Astronautics

A PUBLICATION OF THE AMERICAN ROCKET SOCIETY

NOVEMBER 1958

1958 ASTRONAUTICS ANNUAL —— ARS 13TH ANNUAL MEETING PREVIEW


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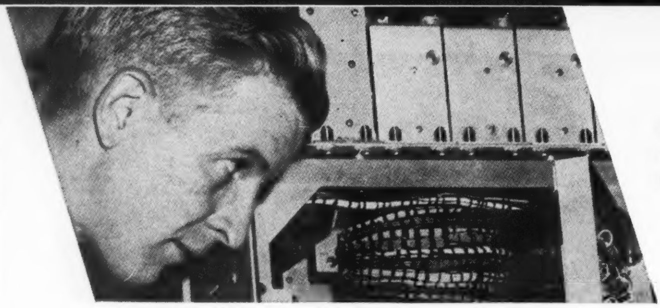
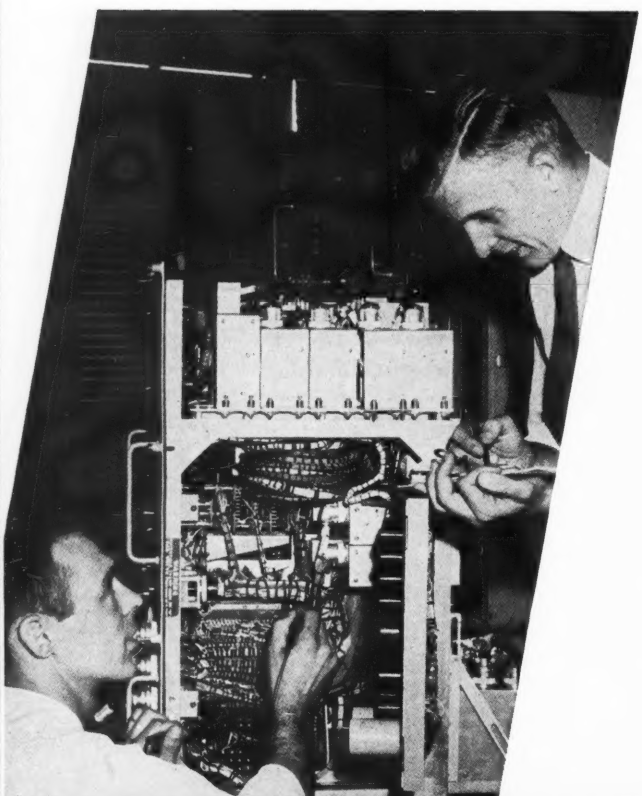
Jack Gaughan





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A PUBLICATION OF THE AMERICAN ROCKET SOCIETY, INC.

November 1958 volume 3 number 11

EDITORIAL

FEATURES

STATE OF THE ART, 1958

ANNUAL MEETING

NEWS

DEPARTMENTS

ASTRONAUTICS is published monthly by the American Rocket Society, Inc., and the American Interplanetary Society at 20th & Northampton Sts., Easton, Pa., U.S.A. Editorial offices: 500 Fifth Ave., New York 36, N. Y. Price $9.00 a year; $9.50 for foreign subscriptions; single copies $1.50. Second-class mail privileges authorized at Easton, Penna. Notice of change of address should be sent to Secretary, ARS, at least 30 days prior to publication. Opinions expressed herein are the authors' and do not necessarily reflect those of the Editors or of the Society.

Astro notes

SPACE FLIGHT

• AF added a notable postscript to Krafft Ehricke's report on space flight (page 46) with its Pioneer lunar probe firing on Oct. 11. While falling more than half short of its target, Pioneer did manage to achieve the deepest known penetration of space to date (79,000-plus miles) before plummeting back to earth on Oct. 13. Aiming error in autopilot of Thor booster was responsible for the short fall. It programmed the system about 3.5 deg higher than the intended trajectory, resulting in loss of crucial 2 per cent of total desired velocity, or some 800 fps less than the necessary 35,000 fps.

• Pioneer nevertheless provided some vital data on "near space" during its two-day flight. Most important instruments carried were the ion chamber, which provided a picture of charged particle density, and the magnetometer, which gave a profile of the terrestrial dipole magnetic field many miles into space.

• Notably absent among top brass witnessing the Pioneer firing were ARPA's Roy Johnson and Herbert York, reportedly uninvited by NASA despite the fact that ARPA was in charge of the lunar probe program from its inception until Oct. 1, just 11 days before the launching attempt was carried out.

• An equatorial launching site will be vital for extensive man-in-space activities, according to James Dempsey, Convair-Astronautics general manager. He estimates such a site might cost \$100 million, with another \$100 million needed for a global communications network. Dempsey believes the site should be operated by NASA. It would permit highly precise satellite orbits, vital for space rendezvous operations, as well as launchings into the moon's orbital plane or the plane of ecliptic for interplanetary probes.

• Following the request of the Committee on Contamination in Extra-Terrestrial Exploration (CETEX), the U.S. agreed to sterilize lunar vehicles and aim them to avoid impact on the moon. CETEX drafted the report leading to this action at the Hague last May.

MAN IN SPACE

• ARPA Chief Roy Johnson told an audience of 300 at dedication ceremonies for CBS Laboratories' new research center in Stamford, Conn., that U.S. will orbit a manned satellite in 24–36 months.

• Balloons will be in the news till then. Lt. Clifton McClure, making a Manhigh flight from Alamogordo, N. Mex., last month, almost reached an altitude of 100,000 ft before failure of the gondola cooling system forced him to land prematurely.

SATELLITES

• Aerojet-General's Avionics Div. reports that it has tracked Sputnik III with IR detectors. The division is working on IR instruments for space navigation.

• Soviet satellite data indicate that meteoric material falls on earth at a rate of 10 million tons a day. Maurice Dublin of AF Cambridge Research Center and his associates estimate 3000 tons per day from U.S. data, and attribute varying estimates in part to differences in instrumentation and data reduction.

MISSILES

• Pushing development of Nike-Zeus, the Army awarded prime contractor Western Electric an additional \$135 million for the project. The money will go chiefly for experimental hardware, with only \$21 million scheduled to support R&D.

• Spurred by knowledge of Soviet missile progress, AF is pushing completion of hard ICBM launching bases and SAC control sites across the country as Atlas moves into the final stage of development.

• Neil McElroy, scotching rumors of cutbacks in the Titan and B-58 programs, said only technical difficulties might lead to changes in these major projects. Meanwhile, in another area of doubt, the Nike-Hercules debate continued, accompanied by much propaganda from interested parties. The Army appears to be banking on major advances in development of Nike-Zeus to settle the matter.

• Boeing Airplane Co. is conducting B-52 flight tests with a full-scale model of North American's Hound Dog air-to-surface missile. First flight tests of the Mach-2 weapon will get underway at Eglin AFB, Fla., in January. NAA engineers call Hound Dog a "creampuff" project because it requires no new advances in technology. Hound Dog employs a Pratt & Whitney J52 turbojet engine, and uses as a guidance system the same NAA Autonetics Div. autonavigator developed for the A3J Mach-2 bomber which NAA is developing for the Navy.

• The Navy is reportedly having a hard time finding funds to keep Temco Aircraft Corp. at work on a straight air-to-surface missile application of the Corvus. Work is continuing on Corvus as a radar-buster, its original mission.

• Boeing has been awarded assembly contract for AF Minuteman, winning out over Douglas, North American, Martin and Convair.

BUDGET

• Cash outlays by DOD for aircraft and missiles will be $30 million less in fiscal 1959 than in 1958. But the R&D program will get a big boost—from $1.89 to $2.81 billion. This boost may be a target for cuts in 1960.

• W. J. McNeil, assistant secretary of defense and comptroller, made it clear recently that use of $815 million in fiscal 1959 defense funds, voted by Congress in addition to administration requests on such projects as Polaris ($600 million), Hound Dog ($48 million) and Minuteman ($90 million), will depend on "progress" in these developments.

R&D

• Bell Labs expects its research on cathode metal sputtering to develop into a major technique in manufacturing precise printed circuits, including resistors and capacitors.

• Twelve universities, among them the Univ. of Calif., MIT, Univ. of Chicago, Cornell and Johns Hopkins, have formed a National Institute of Atmospheric Research to speed study of the atmosphere.

• Sour note from the 3rd International Symposium on Free Radicals: Free radicals for rocket propulsion do not look promising, in terms of the less than 1 per cent concentrations achieved in laboratories thus far.

ARS

• Thomas W. Godwin and Carl F. Lorenzo of Fenn College, Cleveland, have won the ARS-Chrysler Corp. Student Award for their paper on "Ignition of Several Metals in Fluorine." The award is made each year for the best paper by an undergraduate or graduate student in the field of astronautics. First winner of the newly established ARS-Thiokol Award, to be given each year to graduate students who have made a notable contribution to the field of astronautics, is Frederick H. Reardon Jr. of Princeton's Forrestal Research Center.


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The mail bag

Rocket Mail Pioneer

Dear Sir:

Your most interesting picture article "Rocket Mail History—In Stamps" (ASTRONAUTICS, August 1958, page 40) innocently perpetuates an error of fact concerning the "experimenter" who prepared the rockets used in the first international mail flights from the U.S. to Mexico, and Mexico to the U.S. The original error probably was made in Billig's "Rocket Mail Catalog," which incorrectly states that Prof. Goddard was the experimenter. A later supplement to Billig set the record straight.

The actual experimenter was a 16-year-old youth named Keith E. Rumbel, whose hobby interests in rockets and printing sparked the idea and supplied the technical skills for the flights, which were part of an American Legion Post convention program.

ARS members will be pleased to know that this historical correction does not deprive the Society of a direct association with the key rocket personality connected with the event. Keith Rumbel maintained his interest in rocketry and became an ARS member. He is now vice-president of Atlantic Research Corp., where he has made numerous technical contributions to the science and art of modern solid propellant rocketry.

The McAllen-Reynosa mail flights claim two "firsts." They appear to have been the first international mail rocket flights, and also to have been the first such flights using solid propellant rockets. . .

DeWitt O. Myatt
Atlantic Research Corp.
Alexandria, Va.

Cheap Rocket Mail?

Dear Sirs:

I was very interested in your "Jupiter-Mail" item on page 81 of the August issue. But one of the more interesting features of the guided missive to Gen. Taylor is the cost of the postage! Either the ABMA team is so lacking of funds from Washington that they could not afford to send more than a postcard, or "rocket mail" is much less expensive than conventional airmail by a factor of 2¢.

Now I have only one teenie comment to make. In "Astro notes" it says the Vanguard program will probably not be dropped because there are no other "large-scale" satellite programs planned. My question is, why can't they stick with a small-scale satellite project like the ABMA Explorer series? They have been doing all right for themselves without all the fuss, and so far their shots have been 75 per cent effective, which is a lot more than can be said for Vanguard.

Don't get me wrong; I have enjoyed ASTRONAUTICS a lot. It is a perfect companion magazine to JET PROPULSION. Keep up the good work!

Stephen A. Kallis Jr.
716 John Jay Hall
Columbia Univ.
New York 27, N.Y.

Praise for Covers

Gentlemen:

Just a word of appreciation for your fine publication. In addition to timely articles and a convenient news digest, an outstanding feature is the attractive cover of most of the issues. I refer, particularly, to the symbolic painting on the current September issue. Other people have also remarked on this painting.

Would it be possible for you to make enlargements of some of these covers and offer them for sale to members of the Society and subscribers to the magazine? They would be ideal for offices, lobbies and studies. Such use of these illustrations would serve to attach lasting value to the effort that has gone into their preparation.

Albert A. LeShane
Portland, Conn.

How do ASTRONAUTICS *readers feel about the covers? If sufficient interest is indicated, efforts will be made to obtain extra copies and offer them to readers at cost—Editor.*

Re Dornberger's Article

Dear Sir:

If reprints of Dr. Dornberger's article entitled "The Lessons of Peenemuende" (March ASTRONAUTICS, page 18) are available, I would like a few to send to congressmen and senators, and others who might be interested. . .

MAJ. JAMES R. RANDOLPH
490 Tremont Ave.
Orange, N.J.

They're on their way—Editor.

Vernier Thrust Control

Gentlemen:

R. S. Newman in the March issue of ASTRONAUTICS takes up the problem of obtaining dual thrusts. However, he fails to mention any of the work now being carried on in the field of vernier control of thrusts. Certainly the more or less haphazard methods now existing are not suitable for any case where an optimum of control or guidance is wished.

If the ultimate use of the rocket is to transport man on earth and into space, an effective means of varying the thrust should be available. Steps in this direction are changes in nozzle geometry and the regulation of fuel flow. Of course, most of this is in the theoretical stage, but there is no reason why the above methods or others should be laid aside for another moment.

If the recent proposal of Richard Upton is implemented, perhaps a rocket with vernier thrust control could be started. We have seen all too dramatically what the price for procrastination is. If the ARS initiates such a program, what were dreams and speculations just a while ago would become a reality.

LANCE W. SMALL
515 Westchester Ave.
Yonkers 7, N.Y.

Marines Will Do It!

I have been keeping track of most of the information about satellites and the discussions about who is going to get to the moon first.

To me, it's obvious that it's the Marines who'll be *first* to land on the moon.

A Marine Corporal
3rd Marine Division
Okinawa

Capital wire

News highlights from Washington

SATELLITES

• By year's end, perhaps sooner, AF will try to orbit a 250-lb test prototype of its WS-117L reconnaissance satellite. Launching vehicle may be a two-stage Thor-Able, utilizing Aerojet's beefed-up Vanguard motor. Meanwhile, Bell Aircraft is developing a more powerful second-stage motor for the Thor system based on the rocket-powered bomb pod it originally developed for the B-58 Hustler. Prototype recon satellite will use a television link to the ground but AF is interested in Navy-developed scanning and transmitting system for use in later observation satellites.

• Despite the Navy's failure to slip its seventh Vanguard satellite into orbit in September, officials in Washington were confident at least one of the four remaining Vanguards will be successful. This is the minimum necessary to fulfill the U.S. commitment to place at least one instrumented Vanguard satellite in orbit during IGY. Scheduled next is the magnetometer experiment, which will also include a 30-in. inflatable aluminum sphere for density tests.

• Set for October launching aboard an Army Jupiter-C (Juno I) was NASA's 12-ft inflatable sphere, although a high altitude test of the ejection and inflation of a similar sphere failed at Wallops Island, early in September. The sphere will be used for density and radar tracking experiments, while a 100-ft sphere to be launched next year aboard a Juno II (using Jupiter as first stage) will be tested for long-range, HF radio reflection properties.

SPACE ECONOMICS

• At a recent space packaging seminar here, Heinz Koelle of ABMA gave these estimates of satellite payload costs: For Vanguard, about $1 million per pound; for Explorer, $80,000 to $100,000; for Soviet Sputniks and near-future U. S. launching systems using Atlas and Titan vehicles, $1000. Ultimately, payload cost may be trimmed to $100 a pound, possibly through application of nuclear propulsion. "That is about the time where commercial space flight will begin," Koelle forecast.

• Economic benefits from space technology may likewise be huge. Francis W. Reichelderfer, Weather Bureau Chief, has estimated that accurate, long-range weather forecasts made possible by meteorological satellites will be worth several billions of dollars a year, while Wernher von Braun believes special communication satellites will "pay for trips to the moon and other ventures in this business." Gilford Quarles, Chief Scientist for the Army Ordnance Missile Command, has pointed out that a single iron-nickel asteroid 200 ft in diam would be worth $1 billion at present market price.

CIVILIAN SPACE PROGRAM

• With $301.5 million in the kitty and a batch of glamorous space projects in hand, NASA formally opened its doors for business in October. It took over the Navy's Project Vanguard outright, including John Hagen and more than 150 NRL personnel. It also assumed direction of the Army Explorer program and both the AF and Army lunar probe programs. NASA boss Keith Glennan endorsed the plans developed by Hugh Dryden, his deputy, for future NASA projects, including the man-in-space program, exotic propellants, advanced satellites and the development of space technology, with the proviso that plans will be subject to continuous review and modification.

• The International Council of Scientific Unions served notice on the U. S. and Russia that it would like to have an allocation of future satellite payloads for use by scientists of countries lacking satellite launching capability. To keep tabs on space developments after the close of IGY at the end of the year, it proposed to create a Committee on Space Research (COSPAR). The group would arrange for tracking satellites and space probes, collection of data telemetered from them, and the allocation of any satellite payload made available for foreign experiments.

MISSILES

• Failure of initial attempt in September to fire Atlas its full design range of 5500 nautical miles was traced to an over-stressed gearbox in one of the Rocketdyne boosters. North American is rushing a "fix." (The same defect may have spoiled the first AF lunar probe attempt in August, since both Thor and Jupiter employ the same booster as Atlas.) Despite the latest trouble, Atlas engineers believe they have licked all the major engineering problems and that the bird holds no more "surprises."

• Successful development by AVCO of a lightweight ablation nose cone could increase Atlas' range to 7500 nautical miles. The nose cone concept was tested successfully this summer in the Thor-Able flights from Cape Canaveral to the South Atlantic.

• AF is dead set against using the Navy's Polaris as a second-generation IRBM, although it is taking full advantage of the same advances in solid propellant technology in its own Minuteman ICBM program. I_{sp} of 240 lb-sec has recently been achieved in a solid propellant motor. This means Polaris should be able to achieve its full design range of 1500 nautical miles, and that Minuteman will be able to carry out intercontinental missions.

MAN IN SPACE

• Rollout of North American's X-15 was scheduled for mid-October, with two additional models following this month and next. NAA test pilot Scott Crossfield is scheduled to make glide tests from a B-52 bomber before the end of the year, with first powered flights to come in January. Since RMI's high-thrust engine is not expected to be ready by January, first powered flights will use clusters of the 1500-lb thrust barrels used in the X-1A. Crossfield, incidentally, is forbidden by contract to attempt to set new altitude or speed marks while testing the ship. Such attempts are reserved for the AF, which will get the X-15 in mid-1959 or perhaps even later.

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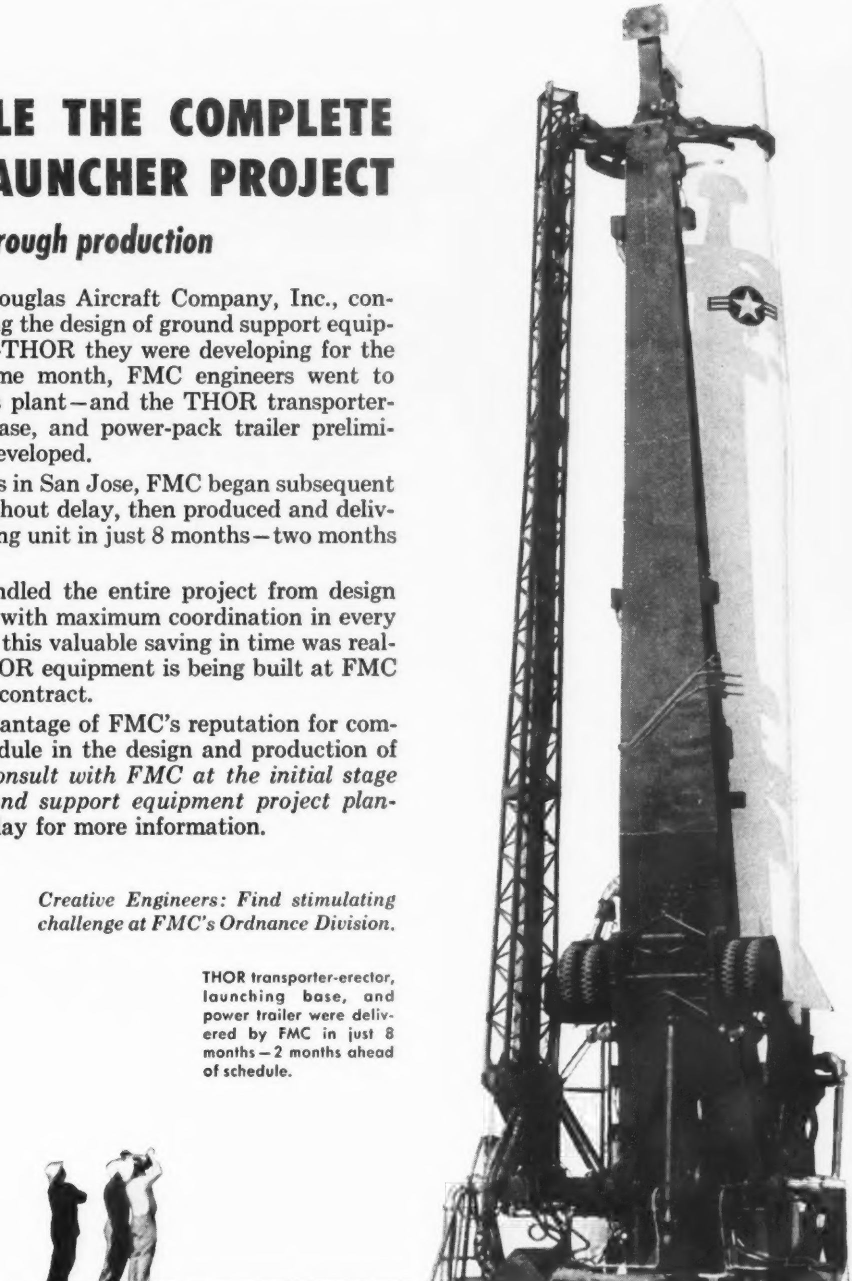

THOR transporter-erector, launching base, and power trailer were delivered by FMC in just 8 months—2 months ahead of schedule.

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For the record

The month's news in review

Sept. 1—AF School of Aviation Medicine reveals that high altitude experiments indicate best ages for space flight are between 30 and 45.

Sept. 4—Lt. Gen. James H. Doolittle (AF-Ret.), chairman of the AF Scientific Advisory Board; NSF Director Alan T. Waterman; NAS President Detlev W. Bronk; and William A. M. Burden, former assistant secretary of commerce, are named by President to NASA Council.

Sept. 5—AF cancels plans for second lunar probe shot this month.

Sept. 6—Army discloses field-type mobile launcher is being developed for Nike-Hercules.

Sept. 8—ONR balloon tows 1400-lb telescope camera to 104,600-ft altitude.

—Navy lieutenant stays in simulated space chamber for record 72 hours.

Sept. 9—NRL says Explorer IV's 108 mc radio transmitter has blacked out.

—AF X-7 ramjet, built by Lockheed, becomes fastest air-breathing missile, surpassing Mach 4.

Sept. 10—DOD Secretary Neil H. McElroy orders Army and AF to halt missile rivalry.

Sept. 11—NASA fails in attempt to launch 12-ft inflatable satellite.

Sept. 12—Army lets $2 million contract for 1.5-million-lb thrust booster to Rocketdyne.

—NASA reveals plans for converting Wallops Island, Va., test station into satellite launching base.

Sept. 14—AF Atlas ICBM successfully fired.

Sept. 16—Navy Vanguard firing is halted just before takeoff.

—First Regulus II missile is successfully launched from Navy sub, but recovery gear fails.

Sept. 17—Army cancels Dart anti-tank missile program.

Sept. 18—AF Atlas, slated to go full range of 6325 statute miles, blows up 80 sec after takeoff.

Sept. 24—Navy Polaris test missile is destroyed when it strays off course.

Sept. 25—AF Bomarc, launched from Cape Canaveral by SAGE system in Kingston, N.Y., racks up kill of 1000-mph drone 75 miles away.

—AF jet plane blasts a classified air-to-ground test rocket into Atlantic.

Sept. 26—Navy fires 20-in. Vanguard, but fails to place it in orbit.

Sept. 28—AF reports Thor has been chosen over Army's Jupiter as basic U.S. mass-produced IRBM weapon.

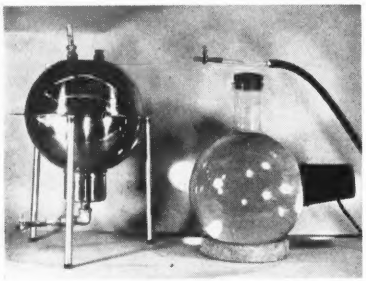
Sept. 29—IGY scientists report first successful test-firing from shipboard of Nike-Asp 150 miles above Pacific, in preparation for Oct. 12 solar eclipse.

—AEC fires nuclear test weapon from a balloon 1500 ft over Nevada desert.

—DOD denies AF report that decision has been made as yet between Thor and Jupiter missiles.

—U.S. agrees to decontaminate lunar vehicles.

Ultrasonics Gaining Wide Application



Laboratory-size degasser being produced by Narda represents one of many applications of ultrasonics reduced to practical form. High frequency waves cause a random decavitation effect, breaking intermolecular binding to give a rapid and high degree of deaeration. On the left is the original laboratory test model.

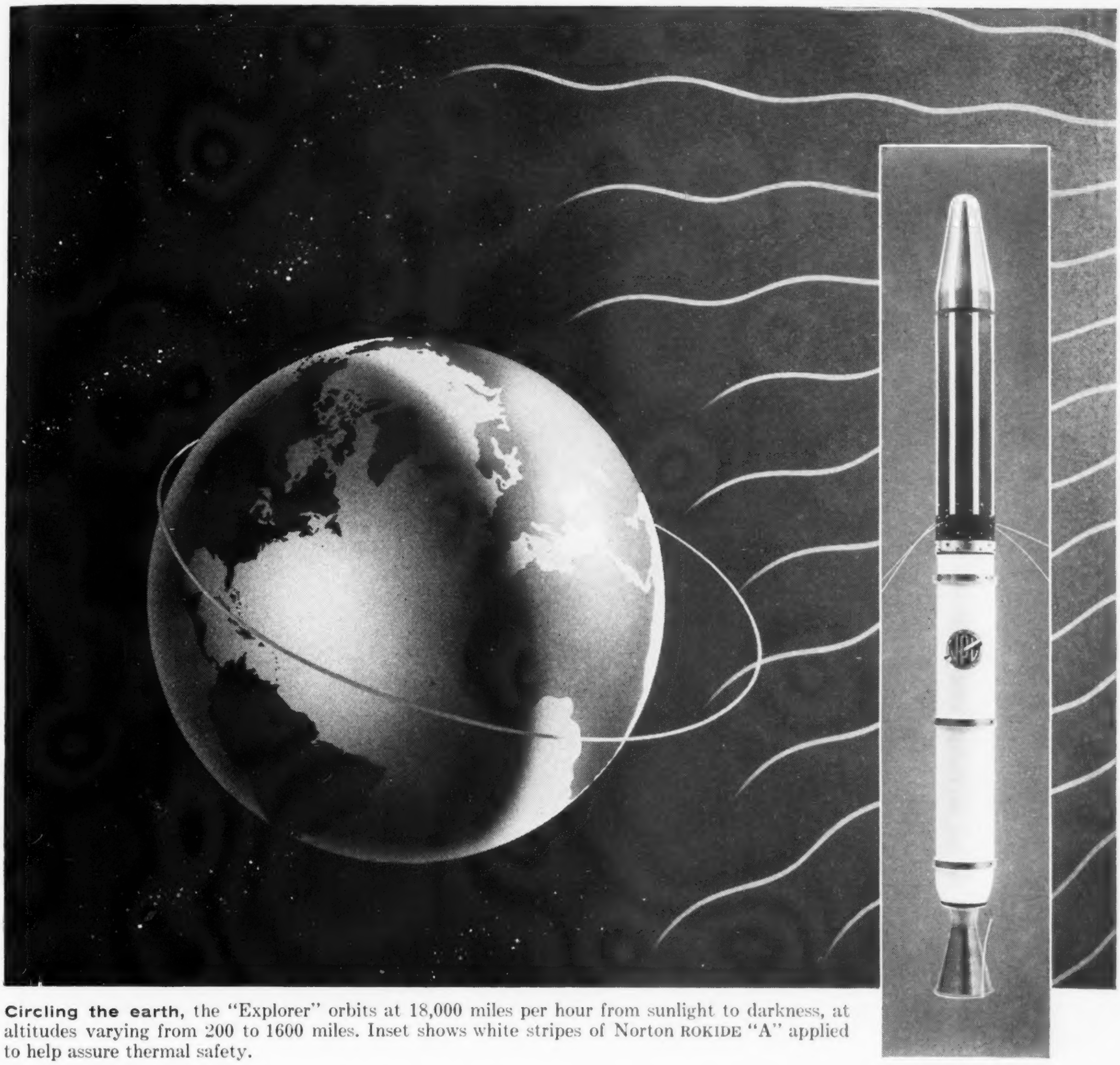
Only a few years ago regarded as a curiosity, ultrasonics has been reduced to practical commercial form as a method of cleaning and finishing a great variety of things, many of importance to the missile industry—lox components, filters, optical parts, castings, semiconductors, printed circuits, film, etc.—and is receiving engineering study for such novel purposes as deaerating liquids, controlling the rate of chemical reactions and measuring the chemical aging of solid propellants.

Business is brisk for a number of firms which have had the foresight and tenacity to engineer ultrasonic equipment, particularly for cleaning. Narda Ultrasonics of Westbury, Long Island, for instance, which began operations only a year ago with a line of cleaning tanks under the trade name, SonBlaster, finds sales running at the equivalent of $1.5 million a year and expects this rate to double in the coming year. This company offers the services of an engineering lab to custom build ultrasonic equipment.

Space Flight Lectures Published by Franklin Inst.

The series of 10 lectures on astronautics given by Franklin Institute, Philadelphia, will be published as its Monograph No. 6, under the title "Ten Steps into Space." The monograph, which will be available early next month, is priced at $4, and may be obtained by writing to the Institute, 20th St. and Parkway, Philadelphia 3, Pa.

The lectures attracted an average attendance of about 400 persons, according to I. M. Levitt, director of the Institute's Fels Planetarium, who coordinated the series.



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Nike Hercules missile blocks sneak attacks

On guard at the outskirts of all major American cities and industrial centers, missiles of the Douglas Nike family are designed to intercept and destroy attacking aircraft—despite the most vigorous evasive action.

Nike-Ajax was the Army's first supersonic anti-aircraft missile. The basic design readily lends itself to new developments as anti-aircraft requirements change.

Nike-Ajax batteries are now being integrated with a newer Nike—the Hercules, developed through the joint cooperation of Douglas, Western Electric and Bell Telephone Laboratories. It has twice the range and speed of its predecessor. Armed with an atomic warhead, Nike-

Practice firing at White Sands Proving Ground of the Army's new medium-range Nike-Hercules interceptor missile

Hercules can blast entire attacking fleets of aircraft with a single shot—without damage to surrounding terrain.

Designed primarily for the inner line of our overall air defenses, Douglas Nike missiles are radar guided from ground installations. Within seconds of the first alert, they can be off towards their target—with deadly aim.

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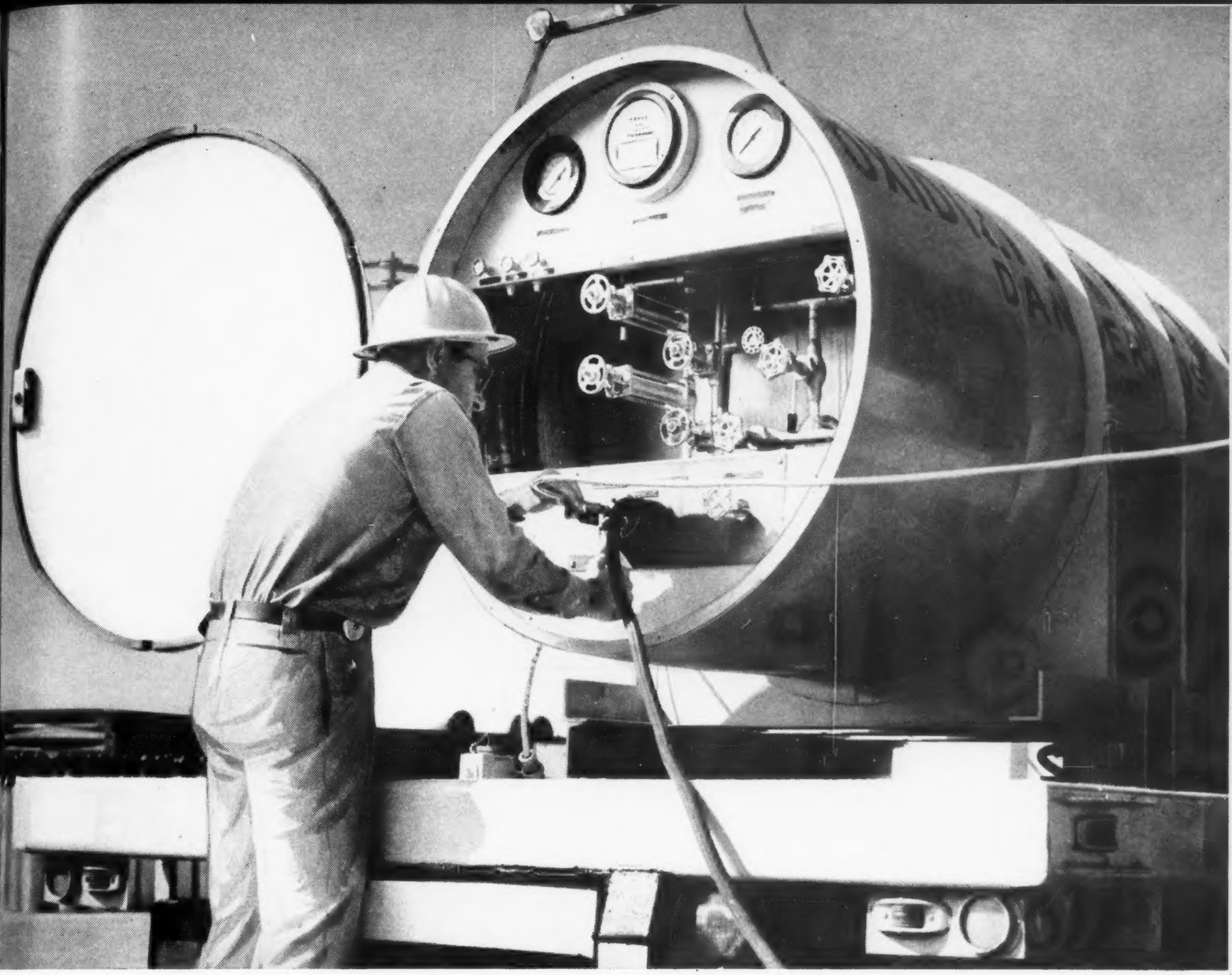


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HOLY BIBLE
ELEMENTS

COVER: *This poetic U.S. Army photo of a Jupiter-C, poised in its gantry at Cape Canaveral a few hours before starting on its journey into space, symbolizes the theme of this issue—man's entry into the Age of Space.*

Astronautics

NOVEMBER 1958

The President's Letter

This year's Annual ARS Meeting comes as the fitting climax to what might well be called "Year One of the Space Age." The reports of the Chairmen of the ARS Technical Divisions in this issue indicate just what progress has been made and what the future holds in store as we enter what promises to be one of the most exciting periods in mankind's long history.

The program for the annual meeting reflects this excitement. Fittingly enough, three technical sessions will be devoted to space flight, compared to the one session devoted to this subject at previous meetings. The papers to be presented at these sessions, as well as at other technical sessions during the meeting, tell a story of great achievement during the past year for the U. S. At the same time, they articulate the many problems that lie ahead.

Nor do the technical sessions tell the entire story, for there are "extra added attractions" as well—three luncheons and the annual Honors Night Dinner, each highlighted by a major address by a figure of national prominence; the award and fellow membership presentations; the Astronautical Exposition; the Annual Film Night; the second annual Eastern Regional Student Conference; and last, but by no means least, the opportunity to meet professional men in your own specialty.

It seems ridiculous to herald each Annual Meeting as "the best ever," but, as ARS has grown and expanded, so has the program for these meetings. This year, the program has something to offer to almost every one of the 12,000 ARS members, which may account for the fact that advance registration indicates a total attendance of some 4000.

It is with a good deal of pride and pleasure that I take this opportunity to invite you to be in their number when the Thirteenth Annual ARS Meeting opens at New York's Hotel Statler on November 17th.

George P. Sutton
President, AMERICAN ROCKET SOCIETY

Space flight: A look ahead

An integrated astronautical program, backed up by continued financial support and strong public interest, can result in almost limitless accomplishments in the next 25 years, says this panel of experts

THE PAST YEAR has been a momentous one in the history of astronautics. It has seen man take his first steps into space. It has brought with it shocked acceptance of Soviet competence, perhaps even superiority, in a domain we have until now tended to regard as exclusively our own. It has brought about formal recognition of the urgent need for establishment of a national space flight program.

Above all, the past year has made the entire world space conscious and, in so doing, has given rise to an atmosphere in which space conquest has become a major technological, as well as political, issue. In this climate, pronouncements as to what the future holds—many of them careless, irresponsible or delivered to further personal ends—have tended to give a distorted impression of what can be accomplished in the years to come.

Now, however, the situation has started to jell and the outlines of the race into space have grown clearer. Reorganization of DOD, establishment of NASA and ARPA, the industry changeover from manned aircraft to missiles and space vehicles, and continued public interest in astronautics offer some indication as to what may be expected in the foreseeable future.

Consequently, we have asked a number of leading figures in the field of astronautics and rocketry to take a long, hard look at the next 25 years of space flight and write something now which, if examined in 1984, will still look good.

We think these nine contributions fill the bill. —I. H.

Theodore von Kármán, *Director, AGARD*

HISTORY has taught us that military necessity often leads to scientific progress. Thus, a military need which dictates the establishment of a national space flight program is likely to bring with it major scientific advances.

It is only necessary to examine the state of aeronautics in the years before and after WW I, or the state of both aerial transportation and rocketry before and after WW II, to see how scientific and industrial progress has gone hand in hand with the needs of the military. In this generation, the Cold War is supplying the same type of impetus to basic scientific research.

As a scientist, I accept the fact that military necessity makes funds available for the study of new sciences, such as aerothermochemistry or magnetofluid dynamics, which may provide the answers to specific military problems.

While, as a human being, I may deplore the fact that often it is *only* military necessity which furnishes the support for research of this kind, it is heartening to note that such work cannot help but ultimately provide innumerable scientific benefits to public welfare.

It does not take a crystal ball to appreciate that major scientific discoveries will occur over the next 25 years. Whole new fields of science will open up as we investigate high energy fuels, ionic and electromagnetic rockets, and study the use of solar energy, plasma jets and, perhaps most important in the long run, nuclear energy, in our search for new means of propulsion to carry man away from the earth. Techniques, structures and materials as yet undreamed of will be found to do the job.

It takes a considerable degree of courage to make detailed predictions about the future. However, I am perhaps more fortunate than most of my colleagues who occasionally brave a prophecy in that, 25 years from now, when I am looking back on these remarks, I will undoubtedly be doing so not from the earth, but from the scientists' Valhalla!

Hugh L. Dryden, *Deputy Administrator, NASA*

WHAT will be the accomplishments of the next 25 years of space research and exploration? What will be the impact of these accomplishments on our intellectual and social horizons, and on our way of life?

It is easier to prophecy what *can* be rather than what *will* be. For what will be depends on the sacrifices that our people and those of other nations are willing to make to devote their wealth, skill and labor to explore this new frontier in the absence of the promise of early returns on the investment. Will we, like Queen Isabella of old, devote a considerable fraction of the national wealth to expeditions to search out the unknown?

There lies ahead a number of new roads into the unknown, and we can travel any or all of them. The one that seems most essential and basic is the development of greater propulsion capability, without which our progress will be slim and limited. In a few years, we can have thrusts of several million pounds in chemical rockets; in a decade, nuclear propulsion of still greater capability; and after that, true space propulsion systems of the ion or plasma type. In 25 years, we can have propulsion systems adequate for space vehicles traveling within our solar system.

The probing of our solar system by instrumented and automated vehicles can be far advanced in 25 years, sufficient to map out the radiation field, electric and magnetic properties in space and near the planets, neutral and charged particles, other physical and chemical characteristics of the space environment, and much information about the planets. Astronomy can be revolutionized. No one knows what new phenomena are still to be discovered or the depth of understanding of the universe still to be attained.

Another prominent road is that of manned vehicle development. We hope to have a man circle the globe in a satellite within a few years. In 25 years, we can have closed ecological systems permitting very long sojourns in space vehicles and we can land and return men from the moon and the nearby planets.

In 25 years, we can use space vehicles for extensive systems of communications and meteorological observations, and perhaps other peacetime purposes. In this period, we can discover and develop military weapons.

All these things and others can come to pass and can profoundly affect our intellectual and spiritual outlook, as well as modify our daily lives as much or more than has the development of aviation. I predict that many of them will come to pass during the next 25 years.

Simon Ramo, *President, Space Technology Laboratories*

THE WHOLE next 25 years may be seen later as only the preliminary to the real space age. True, it can be said that the space age has started now because we have satellites in orbit, are engaged in our first shots at the moon and are already in the first stages of man-in-space programs. Also, it seems clear now that the next 25 years will see the skies filled with numerous instrumented space vehicles, as well as manned visitations to the moon and probably even to Mars and Venus.

However, during this quarter century, almost all space ventures will be tied to earth operations. Communications and navigation satellites, military systems involving ballistic missiles and satellites, weather prediction and control systems, international TV hookups—all will be characterized by multibillion dollar complexes of men and machines. Still, more equipment and complexity in these systems will exist on the surface of the earth than up in space, and each space element will be tied intimately to ground components, the whole objective being to make for superior operations of the earth's predominantly "surface" civilization.

Perhaps about 25 years from now we will be commencing man's real entry into space and man's emergence as a three-dimensional space being. That is, we will be implementing plans for the setting up of permanent colonies on the moon and on other planets. We will really be developing the huge spaceships that, as the comic strips have pictured, will carry hundreds or even thousands of people for flights that could last for an appreciable part of a lifetime. We will have learned better how to control energy and how to associate matter and energy so as to provide what is needed for the colonies and the extended flights.

When this happens, then will we truly have the space age before us—an age in which transportation, communications and logistics between populated points away from this earth will open up a new pattern of life for the "earthmen."

Wernher von Braun, *Director, Development Operations, ABMA*

LAUNCHING of Sputniks I, II and III demonstrated the Soviet capability in long-range missiles applied to orbital technology. The U.S. proved its ability in the satellite field by the launchings of the Explorers and the Vanguard, but the contrast between those relatively low payload weights and the Soviet achievement has not escaped notice.

The key to rapid expansion of our capability in space exploration lies in a unified program utilizing all of the existing development teams and facilities. Only by means of a well-coordinated plan can we hope to overtake and ultimately surpass the Soviets in a race for technological supremacy. Coordination is essential if we are to avoid upsetting the nation's economy and avoid undue drain upon our resources.

An integrated missile and space vehicle program would involve, among other things, the development of five generations of space vehicle families in the next ten years. The first generation is now in existence. It utilizes short-range ballistic missiles, such as the Redstone, for the booster, and has a payload capability up to 33 lb.

The second and third generations will utilize IRBM and ICBM missiles as boosters for space missions. Payload capabilities should increase to 3000 and 10,000 lb, respectively. Fourth and fifth generation space vehicles require the development of new and larger engines and will probably have orbital payloads in the order of 25,000 and 50,000 lb, respectively.

Other requirements for an integrated program would be the development of space navigation and guidance systems, crew engineering equipment and techniques, new and improved test and launching facilities and satellite and space vehicle payload compartments to accomplish such missions as worldwide communications, weather forecasting, astronomical research and provision of transportation for manned exploration of space.

I consider the exploration of space and the extension of human activities beyond the confines of our planet as the supreme challenge of the age in which we live. American leadership in this grandiose project is necessary if western civilization as we know it shall survive.

Only a well-coordinated national program will assure us of this leadership and enable us to develop the new space age technology without wrecking our economy.

H. Guyford Stever, *Chairman, NACA Space Technology Committee*

NOW THAT our country has recognized the importance of space technology and space flight, we can all celebrate. Long sought and now here, governmental blessing of space flight puts responsibility and authority right into the hands of the community of technical people in industry, government and academic institutions.

Given continued financial support and strong interest by the people of the country, what can be accomplished by this community in the next 25 years is almost limitless. Certainly we will explore by manned flights much of the solar system and will land expeditions on some of the planets and the moon; we will put to profit satellites for communications; and our techniques for conducting scientific experiments in space will be more advanced than we can possibly conceive of today.

Should we do all of these things? Certainly. We should and can. I have read somewhere recently that the barriers which might prevent us exist only in the minds of men. I would modify this statement to say that the barriers to our accomplishments are matters of the dominant interests of men.

To date, we have convinced the people of our country to support space work first for prestige purposes. There is something to this argument, but, personally, I believe it is not nearly enough to sustain the general interest for 25 years. We must fall back on two much more basic points: The natural desire of man for exploring both physically and mentally, and his desire to improve his lot. The second of these is often stronger, which is why I would like to see early practical uses of space vehicles for communication relays and similar things to help gain support for our activities.

Herbert F. York, *Chief Scientist, ARPA*

In 25 years, the application of space-based earth-oriented systems in such practical fields as communications, meteorology and navigational aids will have revolutionized these fields and will alone have made this first penetration of the space frontier economically very much worthwhile.

The use of space platforms and probes, large and small, manned and unmanned, for making scientific observations will have vastly added to our knowledge of nearly all phases of our environment, and will consequently have increased our ability to control it and manipulate it to better serve our purposes. The indirect, but none the less real, benefits of this knowledge will have also paid for our space program several times over.

Within the next 25 years, the real business of astronautics will also be well underway—namely, the full-scale exploration of the near parts of the solar system. The riddles of whether or not there is life on Mars and what lies beneath the clouds of Venus will have been solved; great progress in answering the questions of the origin of the planets, the asteroids and the solar system itself will have been made. Semipermanent bases, analogous to those now in Antarctica, will exist on the moon and, perhaps, the near planets.

As for vehicles, the chemical rocket, in much improved form and with thrusts up to many thousands of tons, will continue for the next 25 years to be the workhorse of astronautics. The first manned explorations of the moon, Mars and Venus can, and probably will, be performed solely through the brute force use of chemical rockets. Later, when voyages become more frequent, some higher performance system, based on nuclear rockets, ion or plasma rockets, or solar boiler rockets, will be used for orbit-to-orbit shuttling and for maneuvering space platforms.

The stars themselves will still be out of reach 25 years from now, but perhaps by then we will have reached the same state with respect to interstellar travel as we have just passed in respect to earth satellites and interplanetary travel. In that case, we can expect that some adventurous minds will begin drawing up the first tentative plans showing how it can be done, and others will be busy proving it is unfeasible, uneconomical and unworthwhile.

William H. Pickering, *Director, Jet Propulsion Laboratory*

Twenty-five years ago, in 1933, rockets, guided missiles and satellites were regarded seriously by only a very few slightly crazy enthusiasts. Today, we have a large guided missile industry and a space agency blessed by Congress with broad powers and a large budget.

With this as the background, a prediction 25 years into the future can only be the wildest sort of guess, but here it is:

1. Establishment of manned laboratories aboard space platforms and on the moon.
2. Establishment of meteorological satellites which will provide data to make highly reliable terrestrial weather predictions and localized control of weather conditions.
3. Establishment of a worldwide visual and audio communication system through the use of satellites.
4. Establishment of a rocket cargo and passenger-carrying terrestrial transportation system.
5. Compilation of an accurate compendium of environmental conditions in cislunar and interplanetary space.
6. Compilation of an accurate atlas of the surface geography and climatology of the moon, Mars and Venus.
7. Soft, manned landings on the moon, Mars and Venus.
8. Soft, instrumented landings on Mercury.
9. Establishment of a lunar refueling station, possibly using fuels derived from moon resources.
10. Launching of instrumented deep-space probes, following hyperbolic trajectories to pass in the near vicinity of the outer planets.

If the will exists to accomplish these steps, there are no valid scientific or technical reasons to prevent their accomplishment, provided political and economic conditions are stable.

Andrew G. Haley, *President, IAF*

A SITUATION of almost unprecedented importance exists in the world today, namely, the competition between two great ideological forces. I use the term "forces" advisedly. Although at the present moment the contest for superiority in outer space is being waged between the U.S. and the U.S.S.R., I believe that within the next 25 years—indeed within the next decade—groups of nations will join together to take part in this vast technological endeavor. The Chinese will contribute their immense basic scientific ability to the cause of the East, while England and the not at all defunct British Empire will add great scientific engineering skills to the cause of the West. Other groups will also make their alignments, and the gigantic competition will certainly result in the projecting of vehicles and men into space on a scale now scarcely believed possible.

The first great problem to require solution by the social scientists who are expert in jurisprudence is defining the limits of jurisdiction and sovereignty. Nothing can precipitate a military catastrophe faster than a violation of sovereignty. For some years now, this problem has received the attention of thoughtful men, including members of the International Astronautical Federation, the American Bar Assn. and the AMERICAN ROCKET SOCIETY.

The principle must be established that no force or power may assume jurisdiction of or sovereignty over the moon or any other natural celestial body.

Within the next decade, a complete new code of radio and television regulations, regulations concerning the safety of life and property in space, the regulation of traffic, and so on, must be evolved. Within 25 years, legal principles must be established forbidding sociological mistakes in space exploration, such as contamination of other celestial objects, and likewise prohibiting space explorers from bringing back to earth contaminations picked up in space.

Problems in substantive law will increase as space flight progresses. This involves the entire ambit of law, including the law concerning contracts, torts, evidence, conflicts of law, labor, citizenship, wills, estates, and so on.

The practice of space law will develop as a specialty demanding competence in sociology and technology. The "space lawyer" must prepare himself for a pioneer's role in the space age.

Joseph Kaplan, *Chairman, USNC-IGY*

THE CIVILIAN space flight program should perhaps be more accurately called a civilian program for the study of space science and its application. Enough good proposals for geophysical, solar and other astrophysical studies have been made to the U.S. National Committee for the International Geophysical Year to make excellent use of all of the platforms that might be reasonably provided for the period of the next few years. Add to these the new ideas that are bound to develop, the ideas that the life sciences will come up with and a number of important practical applications, and one can certainly foresee an exciting program in this field.

It is hard and perhaps even useless to try to predict what will happen as a result of any scientific effort. One can only hope that the direction is the right one and that one will have enough wisdom to change the direction in which one is going whenever the progress of the program points to the need for a change.

However, one thing is certain in geophysics, astronomy and now in the scientific aspects of astronautics. Worldwide cooperation is a necessary part of such a program. The value of worldwide cooperation in science has often been demonstrated and in a dramatic way during the IGY. We must not enter a period of expanding activity in space on a unilateral basis if we wish to derive the maximum scientific benefits from this new and exciting field.

NASA staffing up

Silverstein named director of space flight development; Crowley to head space research . . . Six associate directors also appointed

THE NATIONAL Aeronautics and Space Administration, which set up shop October 1 after taking over the National Advisory Committee for Aeronautics, is busily at work staffing up for the tasks that lie ahead.

Early last month, NASA Administrator T. Keith Glennan announced the first in what promises to be a series of appointments to top management of the new agency.

Abe Silverstein, formerly associate director of the NACA Lewis Lab, has been named Director of Space Flight Development, in charge of the entire spectrum of astronautical operations, including design and procurement of vehicles and satellite payloads, launching and monitoring of scientific satellites, accumulation and reduction of data and activities in support of the man-in-space program. In this capacity, he will also direct activities at NASA's Wallops Island, Va., rocket launching station.

John W. Crowley Jr., former NACA associate director for research, has been appointed Director of Aeronautical and Space Research, heading up the basic and applied research programs of the NASA Research Centers (the former NACA Research Labs) in support of aeronautical research and astronautical research and technology, as well as new programs to be carried out by industry and educational institutions.

Albert F. Siepert, former executive officer of the National Institutes of Health, has been named NASA Director of Business Administration.

Three Assistants Named

Silverstein will be assisted by Homer E. Newell, who will be Assistant Director for Basic Sciences; Abraham Hyatt, Assistant Director for Propulsion; and Newell Sanders, Assistant Director for Advanced Technology. Newell was formerly program coordinator for Project Vanguard at NRL, where he headed the Atmosphere and Astrophysics Div. Hyatt was previously chief scientist and research analysis officer, Navy BuOrd, while Sanders was chief of the Physics Div. of NACA Lewis.

Crowley will be assisted by three associate directors: Ira H. Abbott, aerodynamics and space mechanics; Addison M. Rothrock, propulsion; and Richard V. Rhode, materials, structures, loads and operating problems. All three are former NACA assistant directors for research.

Hugh L. Dryden, former NACA director, will, as deputy NASA Administrator, continue to devote the major portion of his effort to development of the agency's scientific programs. John F. Victory, former NACA executive secretary, has been named an assistant to the administrator.

Projects Transferred from DOD

With NASA in business, a number of important projects have been transferred to the new agency by DOD. Included are Project Vanguard; four lunar probes (two AF and two Army), transferred from ARPA; three ABMA satellite projects (which call for putting in orbit 12- and 100-ft diam inflatable spheres and a cosmic ray satellite); and a number of AF engine development research programs, including nuclear rocket engines, fluorine engines and the 1-million-lb thrust single chamber engine.

These shifts will result in the transfer of some ARPA and AF funds to NASA. From ARPA, NASA will receive $9.6 million in fiscal 1959 funds for completion of the lunar probe and satellite programs, plus $49.6 million originally given to ARPA for scientific projects. AF will transfer $57.8 million for the engine development programs.

NASA and ARPA will work jointly on the man-in-space program, with ARPA henceforth concentrating on development of weapons systems, anti-missile systems, and continuing military projects, such as satellite programs for warning, navigations, communications and meteorology and military exploratory space programs. Components for such projects, such as high thrust boosters and high energy upper stages, will also be developed by ARPA.

U.S. civilian space flight program

NASA, through its research and development field stations and contracts with industry and scientific institutions, is already at work preparing for manned flight into space

By Hugh L. Dryden

DEPUTY ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, WASHINGTON, D.C.

Hugh L. Dryden, director of NACA from 1947 until his recent appointment as deputy director of NASA, began his long and distinguished career as an aerodynamicist and scientific administrator when he became head of the Bureau of Standard's aerodynamics section in 1920. In 1934, he became chief of the Bureau's mechanics and sound division and, in 1946, he was named associate director of the Bureau. During WW II, Dr. Dryden headed the project team on BAT, the first U.S. guided missile, and served on committees advising the Joint Chiefs of Staff, NACA, Army Ordnance Dept., and the Army Air Corps. Before being named head of NACA, he was scientific director of the AF scientific advisory group, and in this capacity toured Europe to study foreign scientific work in aeronautics and guided missiles. The author of more than 100 scientific papers, Dr. Dryden is a past president and honorary member of IAS, an honorary fellow of the Royal Aeronautical Society, and home secretary of the National Academy of Sciences.

BY THE TIME these observations appear in print, the National Aeronautics and Space Administration will have absorbed the National Advisory Committee for Aeronautics. The reasons behind the decision of the Administration and the Congress to build the NASA structure using the NACA as the foundation were sound. In this way, NASA was provided with a staff of almost 8000 scientists, engineers and supporting personnel, laboratory facilities valued at more than $350 million, and comprehensive research programs already in progress.

It is necessary to understand, however, that NASA will be a different agency in fact as well as in name. In many ways, NASA's mission will be different. To be sure, the work of the NACA–research on problems of flight within and beyond the atmosphere–must be continued, and perhaps even be intensified, but this effort will be only one segment of NASA programs.

In addition, NASA will have to administer substantial programs of development and procurement, on a contract basis. NASA will spend large amounts of money through contracts with scientific and educational institutions and with industry. NASA will be developing and launching into space vehicles needed to obtain scientific data and to explore the solar system. NASA will be preparing for the day of manned flight into space.

T. Keith Glennan, who took a leave of absence as president of Case Institute of Technology to accept the multiple challenges implicit in his appointment as the first Administrator of NASA, assumed his new duties in mid-September. He brought to the position talents sharpened by successful practice both as an electrical engineer and as an administrator. In the 11 years he was at Case, he substantially raised the standing of that institution. As a matter of fact, not long ago Edward Teller ranked Case with the first four engineering schools in the country.

Perhaps the best way to indicate the magnitude of Dr. Glennan's task is to quote from comments by Sen. Lyndon B. Johnson, made during the confirmation hearings: "There are no blueprints or road maps which clearly mark out the course that the new director must follow. The limits of the job are no less than the limits of the

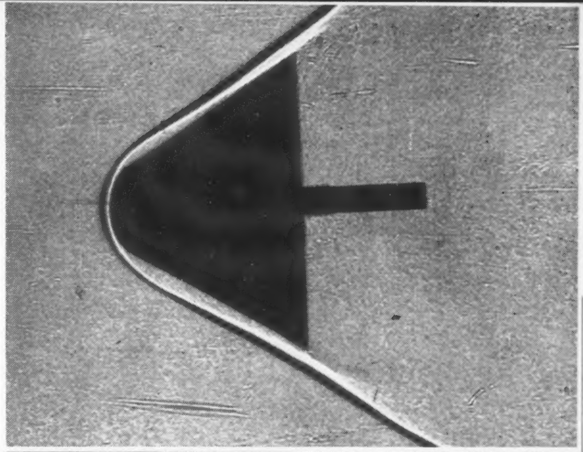
universe. And those are limits which can be stated but are virtually impossible to describe. . . In a sense, (the course of) the agency. . . can be compared to the voyage of Columbus to the New World. The only difference is that Columbus—with his charts drawn entirely from imagination—had a better idea of his destination than we can possibly have when we step into outer space. We do know certain things: We want outer space to be a highway to peace and prosperity and not a road to war. We seek a maximum development of all the potentialities and not just a narrow production of new weapons."

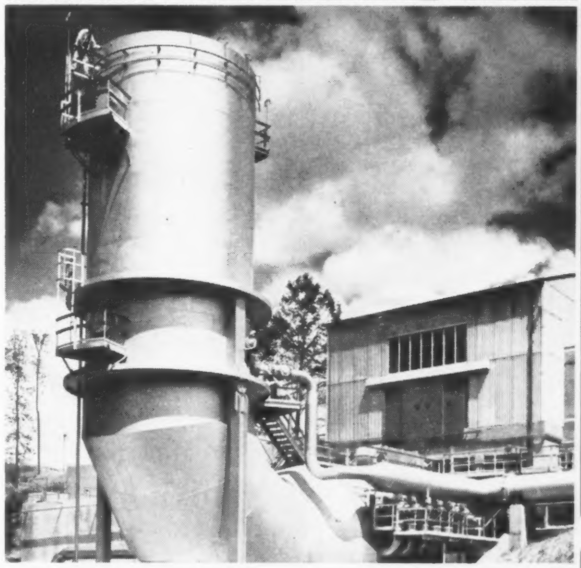
NASA will have about $300 million for its programs in fiscal 1959. Of this amount, approximately one-third will be for continuance of research at the former NACA laboratories and field stations in Virginia, California and Ohio. Most of the remainder, it is expected, will be used to finance work by government agencies, educational and scientific institutions and industrial concerns, under contract to the agency. It is planned that only about 800 new employes will be added, about 650 of them at the new Space Projects Center at Beltsville, Md., just outside Washington, and the remainder at NASA headquarters.

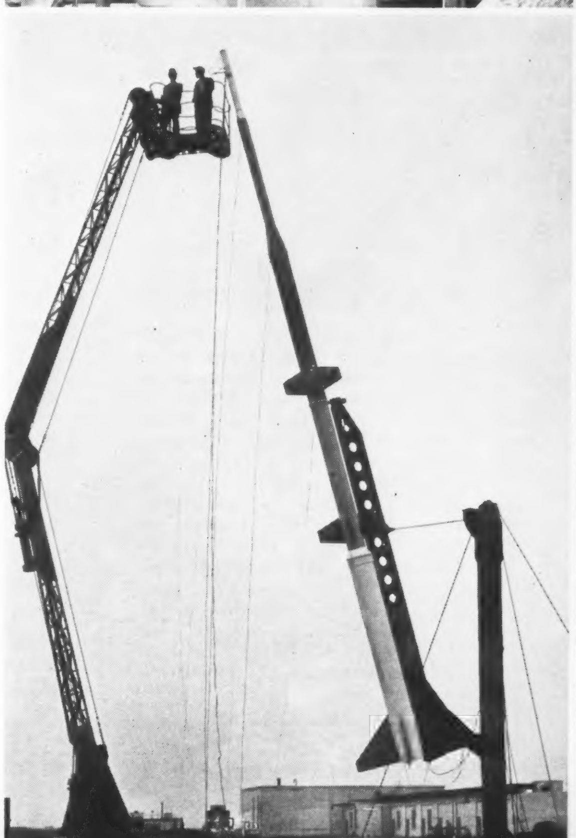
Programs Are Still Fluid

It should be clearly noted that I use the word "plan" in the sense that the NASA programs are still fluid. As a matter of fact, until Dr. Glennan has had the opportunity to study them in detail and make final decisions (this is written less than a week after he reported on the job) they obviously can only be considered tentative. They are the product of effort by the NACA staff in response to instructions from the President on April 2 to work out such detailed plans as would be required to reorient the then current plans, internal organization and management structure of the NACA so as to carry out the functions of NASA, and to plan the new programs necessary to implement then pending space agency legislation.

The work of the Space Projects Center will include project control, the collection of the scientific data returned from vehicles operating in space, and data reduction. A location near Washington was chosen because man- (CONTINUED ON PAGE 73)







NASA brings to the national space program an unexcelled background in theoretical studies of re-entry, typified here by Ames Lab photo (top) of blunt nose cone at Mach 8.3; in combustion of high energy liquid propellants (middle photo shows Lewis Lab exhaust-quenching tanks for rocket engines with fluorine as oxidizer); and in design and operation of multistage rockets such as the one in the bottom photo, ready for firing at Langley's Wallops Island facility.

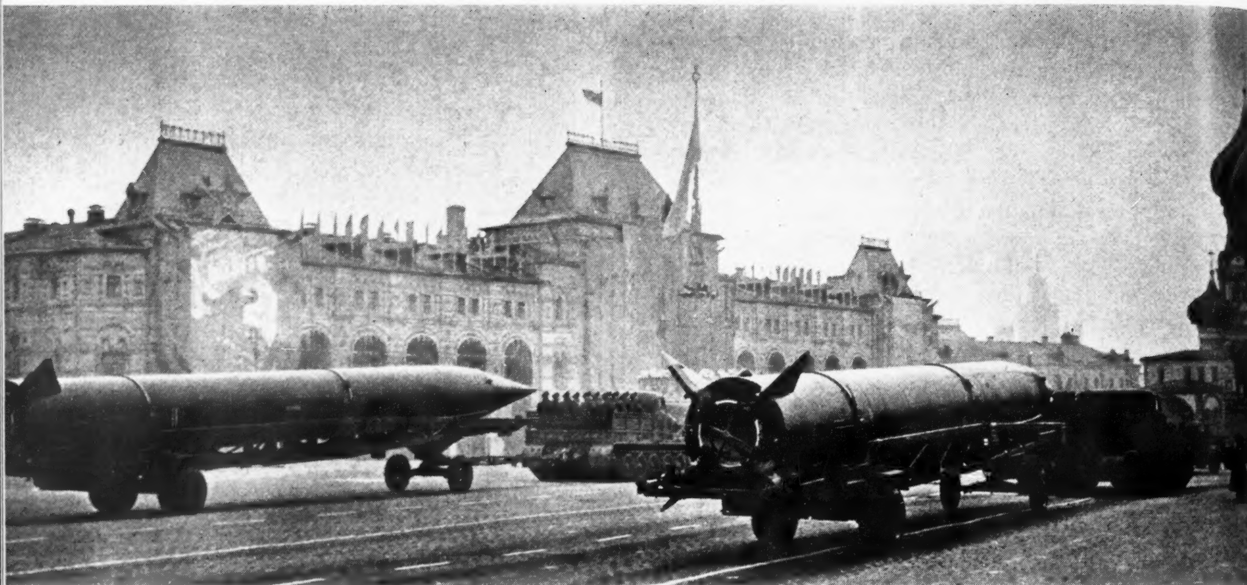


Photo taken during Red Square parade last November depicts two Redstone-like Russian rockets whose size is a lower limit for those used to inject Sputniks into orbit.

One of the country's top analysts of Soviet activities in the field of ballistic missiles and space flight takes you . . .

Behind the Red satellites

By F. J. Krieger

THE RAND CORP., SANTA MONICA, CALIF.

F. J. Krieger is a physical scientist with the Rand Corp., a nonprofit organization conducting long-range research for the Air Force. Dr. Krieger has been with Rand since it was founded in 1945, his fields of research including the chemistry and physics of rocketry and astronautics, and the science capabilities of the Soviet Union. One of the country's top authorities on Soviet activities in the ballistic missile and space flight field, Dr. Krieger is the author of the recent book, "Behind the Sputniks: A Survey of Soviet Space Science," and edited Rand's two-volume "Casebook on Soviet Astronautics," on which the book was based.

ON DEC. 21, 1957, the Central Committee of the CPSU, the Presidium of the Supreme Soviet of the U.S.S.R., and the U.S.S.R. Council of Ministers issued a proclamation in connection with the outstanding achievements that marked the 40th year of existence of the Soviet government. The proclamation ended with the following announcement:

"For outstanding achievements in the field of science and technology, making possible the creation and launching of artificial earth satellites, a large group of scientists, designers and specialists have been awarded Lenin prizes.

"Scientific research organizations that participated in the development of the satellites and in the realization of their launchings have been awarded the Order of Lenin and the Red Banner of Labor.

"For the creation of the satellites, the carrier rockets, the ground launching facilities, the measuring and scientific equipment and the launching in the Soviet Union of the world's first artificial earth satellites, a group of scientists, designers and workers has been awarded the title of Hero of Socialist Labor. A large number of experts, engineer-technological workers and workers have been

awarded orders and medals of the Soviet Union. To mark the creation and launching in the Soviet Union of the world's first artificial earth satellite, it has been decided to erect an obelisk in Moscow, the capital of the Soviet Union, in 1958."

Thus the official cloak of anonymity was draped collectively over the men and institutions that accomplished, with dramatic suddenness, man's first concrete step in the conquest of space. This announcement, in a sense, epitomizes the extreme caution with which the Soviets have handled the subject of rocket development since the mid-1930's when, after the first liquid propellant meteorological research rockets were fired by Russian enthusiasts, the Soviet government quickly realized the enormous military potential of the rocket and organized a government-sponsored rocket-research program, with its attendant security restrictions.

Until the door was shut on the publication of original material in 1935, rocket developments in the Soviet Union, especially those connected with the exploration of the stratosphere, were discussed quite freely. As early as 1929 an organization known as GIRD (after the initials of the Russian words for "Group Studying Reactive Motion") was formed by a number of scientists and engineers, whose primary interest was in rocket engines and propellants. By that year V. P. Glushko, now a corresponding member of the U.S.S.R. Academy of Sciences, was already designing rocket engines, and from 1931 to 1932 he conducted test-stand firings with gasoline, benzene and toluene as fuels and with liquid oxygen, nitrogen tetroxide and nitric acid as oxidants.

Mentioned in Russian Literature

The only liquid propellant rocket engines mentioned by code designation in the Russian literature are the OR-2 engine, designed by F. A. Tsander, which in 1933 developed a thrust of 50 kg operating on gasoline and liquid oxygen; the ORM (experimental rocket engine) series, designed by Glushko, of which the ORM-52 in 1933 developed a thrust of 300 kg operating on kerosene and nitric acid; and the aircraft thrust-augmentation rocket engines—RD-1, RD-2 and RD-3—which developed thrusts of 300, 600 and 900 kg, respectively (1941–1946).

L. S. Dushkin designed an engine that propelled a meteorological rocket designed by M. K. Tikhonravov to an altitude of 10 km in 1935. Dushkin later designed an engine that developed a thrust of 150 kg for a rocket plane (glider) built under the direction of S. P. Korolev and successfully flight-tested in 1940.

After World War II, the Russians thoroughly and systematically exploited (CONTINUED ON PAGE 97)

Цифры, не требующие комментариев

Советские искусственные спутники Земли

	Дата запуска	Вес
Первый спутник	4 октября 1957 года	83,6 килограмма
Второй спутник	3 ноября 1957 года	508,3 килограмма
Третий спутник	15 мая 1958 года	1327 килограммов

Советский Союз запустил в космос три летающие научные лаборатории общим весом 1918,9 килограмма.

Американские искусственные спутники Земли

	Дата запуска	Вес
Первый спутник	31 января 1958 года	Около 14 килограммов
Второй спутник	17 марта 1958 года	1,5 килограмма
Третий спутник	26 марта 1958 года	Около 14 килограммов

США вывели на орбиту три спутника общим весом 29.5 килограмма.

В вес первого и третьего спутников включен вес ракет-носителей.

Вес спутника — это не только показатель мощности запустившей его ракеты. Прямо пропорционально весу и научное значение летающей космической лаборатории. Об этом красноречиво говорит великолепная оснащенность научными приборами советских спутников, особенно третьего.

Table from May 16, 1958, *Izvestia* indicates how Soviet propagandists are making capital out of massive Red satellites. Translation of table is at right.

Figures That Require No Comments

	Soviet Artificial Earth Satellites: Launching date	Weight, kg	American Artificial Earth Satellites: Launching date	Weight, kg
Satellite I	4 Oct. 1957	83.6	31 Jan. 1958	c. 14
Satellite II	3 Nov. 1957	508.3	17 Mar. 1958	1.5
Satellite III	15 May 1958	1327	26 Mar. 1958	c. 14
The Soviet Union has launched into the cosmos three flying scientific laboratories with a total weight of		1918.9	The USA has injected into orbit three satellites with a total weight of	29.5

The weight of the carrier rocket is included in the weight of the first and third satellites.

The weight of a satellite is not merely an indicator of the power of the rocket that launched it. The scientific value of a flying cosmic laboratory is also directly proportional to the weight. The splendid manner in which the Soviet satellites are outfitted with scientific instruments, especially the third, speaks eloquently of this.

Harvest from the IGY

Satellites and research rockets are providing us with our first true picture of space, and especially of its attendant hazards

The earth satellite program

By Albert R. Hibbs

JET PROPULSION LABORATORY, PASADENA, CALIF.

Albert R. Hibbs is chief of the research analysis section of the Jet Propulsion Laboratory, responsible for missile aerodynamics, ballistic calculations and preliminary design analysis. He joined JPL after receiving his Ph.D. in physics from the California Institute of Technology in 1955. Dr. Hibbs is responsible for assuring that Explorers are being tracked successfully, for collecting telemetered data from JPL Microlock receivers, and for analyzing Explorer measurements, and particularly those concerning temperatures and rocket behavior.

THE FIRST two satellites successfully launched by the U.S., Explorers I and III, brought both expected and surprising results about micrometeorites, temperatures and cosmic radiation.

At altitudes below about 1000 km, the counting rate of the satellite Geiger-Müller tubes indicated a cosmic ray intensity which agreed very well with extrapolations made on the basis of experiments with high altitude rockets and balloons. But a sudden anomalous behavior of the counting circuitry was observed above 1000 km. Although satellite measurements were not capable of determining the exact nature of this unusual effect, several corollary pieces of information indicate the following:

At altitudes above approximately 1000 km, for regions between 30 deg north latitude and 30 deg south latitude, there is an intense field of low energy electrons. These electrons, with energies varying from around 50 to 90 kev, produced Bremsstrahlung on impact with the satellite shell. The resulting x-radiation produced a counting rate approximately 1000 times greater than that which would be observed from primary cosmic radiation alone.

Several observations led to these conclusions. The most conclusive results came from the measurements taken by Explorer III, in which the recording apparatus gave data for complete orbits. For Explorer I, the data were not stored but were transmitted to the ground continuously.

There is little concrete evidence concerning the nature of this radiation. Apparently, however, it is not electromagnetic. The shell of the satellite and the walls of the counting tube form a shield with a density of 1.5 grams per sq cm. Photons capable of passing through this quantity of material should certainly have been noticed at much lower altitudes. Certainly they would have been recorded long before this by balloon flights and high altitude rocket observations, and no such observations have been reported.

On the other hand, high altitude rocket measurements in the auroral zone have detected a similar type of radiation. These measurements indicate that the radiation is produced by electrons with energies in the 50- to 100-kev range.

It is presumed, therefore, that a large field of such electrons exists around the earth, more or less trapped by (CONTINUED ON PAGE 110)

The rocket research program

By Homer E. Newell Jr.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, WASHINGTON, D.C.

DURING the first 12 months of the IGY, the U.S. fired some 116 sounding rockets to take atmospheric measurements. The table on page 116 gives the geographical distribution of these firings and the rockets employed. In very brief form, here are some of the key results from the firings:

The upper air densities measured with sounding rockets are in good agreement with the preliminary densities determined from satellite drag computations. Between 30 and 45 km, Arctic density measurements indicate that seasonal and latitude variations are less than 15 per cent, while summer pressure measurements show Arctic temperatues and pressures to be significantly higher than those of White Sands, N.M. Density measurements made at latitudes 49, 58 and 66 deg North suggest a strong latitude variation in atmospheric densities at 50 km (about 2 per cent per deg of latitude). Atmospheric density immediately above the tropopause at Ft. Churchill falls off more rapidly than at White Sands, as evidenced by the scattered light from the horizon in high altitude photographs. At Ft. Churchill, there is a definite single tropopause.

Between 30 and 80 km above Ft. Churchill, atmospheric temperature shows a significant variation from winter to summer, the spread being about 20 C at 50 km. Summer temperature at 80 km above Ft. Churchill was found to be 165 K.

Lower Values Indicated

Ambient pressure, temperature and density measured for most seasons over Ft. Churchill, in the latitude range 30 to 90 km, indicate definitely lower values than accepted standards based upon lower latitudes.

Above Ft. Churchill, between 30 and 80 km, winds were found to be weak and from the east in summer and very strong and from the west in winter, a 150 meter per sec velocity having been recorded at 58 km.

Ultraviolet spectrographic data from 60 to 90 km over New Mexico indicate that the nitric oxide concentration cannot exceed 10^8 molecules per cc. Above Ft. Churchill, on three flights covering fall, winter, and spring, and including both day and night shots, nitric oxide was found to be a negligible constituent of the upper atmosphere, and it was found that diffusive separation of argon and nitrogen became effective at between 100 and 120 km, above which level the ratio A/N_2 decreased steadily with altitude. With regard to the molecular oxygen distribution in the altitude range of 70 to 100 km, a maximum difference of 2 meters was observed in the O_2 atmosphere between two flights in summer and winter.

Above Ft. Churchill, on three flights (CONTINUED ON PAGE 116)

A graduate of Harvard and recipient of a Ph.D. in mathematics from the University of Wisconsin, Homer E. Newell Jr. joined the Naval Research Laboratory in 1944, and became head of its Rocket Sonde Branch in charge of NRL's upper air research program in 1947. He was named to head NRL's Atmosphere and Astrophysics Div. in 1955, also becoming science program coordinator for Project Vanguard. Dr. Newell is a member of NACA's Rocket and Satellite Research Panel, a member of USNC-IGY's technical panel on the earth satellite program, and executive vice-chairman of its technical panel on rocketry. He is the author of several books, a member of ARS, and a Fellow of AAAS. Last month he joined NASA as Assistant Director for Basic Sciences.

Profile—Richard A. Moore

10,000th ARS member

WHILE it would obviously be foolhardy to try to describe anyone as the "typical" AMERICAN ROCKET SOCIETY member, the temptation to do so in the case of Richard Arthur Moore, who some months ago became the 10,000th ARS member, is almost overwhelming.

His interest in rocketry, for example, dates back to his youth. During his high school days, he even went so far as to try to build a rocket in the basement laboratory he had constructed at his home in Pratt, Kan. Much to the relief of his parents, the try ended in failure.

Today, his interest in rocketry has broadened to include astronautics. He is now a senior nuclear engineer at the Convair Nuclear Laboratories in Ft. Worth, Tex., directing efforts toward the development of nuclear power units for space applications. Recently, his specialization has been in the direction of micrometeorite damage on radiator components.

In the words of one of his supervisors at the lab, J. D. Nance, "Mr. Moore is one of the most highly regarded engineers in our laboratories. He has worked with and for me four years, and is tops in his field."

Awarded Scholarship

Born in Pratt, where his family had been established for many years, on Jan. 20, 1930, Dick graduated among the top five of his high school class in 1947, his excellent grades earning him a Summerfield scholarship to the Univ. of Kansas—one of 20 such scholarships awarded each year.

His major educational influences at the university were L. Worth Seagondollar, who built the Van de Graaff proton accelerator, and J. D. Stranathan, head of the school's Science Dept.

While in college, Dick became a member of several undergraduate honor societies, including Tau Beta Pi, Sigma Pi Sigma, of which he was the first president, and Sachem, an honorary society for men. He again graduated fifth in his class, receiving his B.S. in Engineering Physics in 1951.

After graduation, he was appointed to the AEC School of Reactor Technology at Oak Ridge, Tenn., a signal honor, since only about half of the total enrollment of 80 come from universities, and about half of this number already hold M.S. and Ph.D. degrees.

The following year he returned to the Univ. of Kansas to work on his Master's degree in nuclear physics. Here, Dick found it necessary to work part time as a research assistant on the Van de Graaff program to aid in financing his education. This work gave him experience in vacuum system operation, ion source design, beam formation and focusing and acceleration techniques.

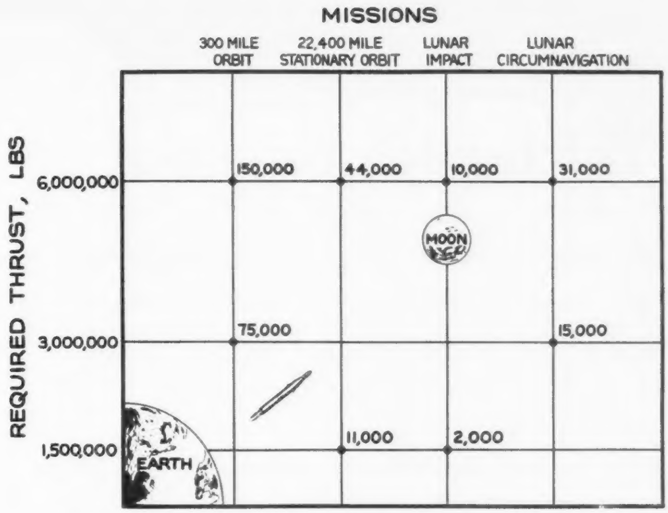
Completed Graduate Work in 1954

In 1954, an eventful year in his life, he completed his graduate work with a thesis on "Gamma Rays from the Proton Bombardment of Vanadium." During the same year, he met his future wife, the former Frances Bivens, at the university, began his career at Convair and entered the army.

Fortunately, he was assigned to the Army Chemical Corps, where his skills could be utilized, being stationed at Dugway Proving Grounds, Salt Lake City, Utah, with responsibility for radiological work associated with gamma radiography and gamma irradiation of foods.

He took time off to get married in April, 1955, and, at the conclusion of his army service, returned to Convair. In 1956, he began work on a nuclear power unit for space applications. This marked his initial interest in space flight, an interest which has grown with additional work on Convair's ground test nuclear reactor and criticality experiments with the aircraft shield test reactor. He has also participated in company studies of lightweight reactor power systems, including preliminary evaluations of electrostatic ion propulsion systems for satellite applications.

Although not professing (CONTINUED ON PAGE 73)



What Giant Engines Mean in Terms of Space Missions

Rocket engines for space flight

Clustering of motors with thrusts of 1 million lb or more would permit orbiting of 22-ton satellites, landing of 10,000-lb payloads on the moon, and launching of 31,000-lb space vehicles

THE RECENT award of contracts to Rocketdyne for development of a single-chamber rocket engine which will deliver 1 million lb of thrust, as well as a clustered booster to provide approximately 1.5 million lb of thrust, marks this nation's first concrete step toward the eventual production of true space vehicles.

For, while both military brass and Rocketdyne officials speak vaguely of possible military uses for high thrust engines of this type, it is difficult to conceive at this moment of missiles requiring boosters in this range, and it is much more likely that they will be reserved almost exclusively for space missions.

The chart above provides some graphic evidence of just what these engines would mean in terms of payload. Booster thrusts ranging from 1.5 to 6 million lb would make it possible to put satellites weighing as much as 44,000 lb in orbit at an altitude of 22,400 mi, or to orbit a 150,000-lb payload at 300 mi. They would also permit landing a 10,000-lb payload on the moon, and could be used to launch space vehicles weighing up to 31,000 lb.

Even more important, such missions could be accomplished in the not-too-distant future. Rocketdyne engineers at the recent ARS Fall Meeting in Detroit estimated that the clustered 1.5 million-lb thrust booster might be developed in a relatively short period of time, perhaps as little as one year. The main element in the booster will be an engine similar to that used in the Jupiter, Thor and Atlas missiles.

Seen As Quickest Method

This approach, utilizing existing motors, was selected because it was considered to represent the quickest and least expensive means of obtaining a booster of the size needed to place very large payloads in orbit. The engine is being developed for ABMA under ARPA cognizance.

Development of the single-chamber engine, for the Air Force, under joint ARPA-NASA cognizance, will take longer, perhaps as long as five years. However, this engine is likely to be the largest chemical single-chamber unit for which an intensive development effort will be undertaken, since it is generally regarded as being capable of handling almost all major missions now in the planning stages.

Thirteenth time out

Sixteen Technical Sessions, four major addresses, Second Annual Eastern Regional Student Conference, Astronautical Exposition to highlight first solo Annual Meeting of ARS, to be held in New York November 17–21

By James J. Harford

EXECUTIVE SECRETARY, AMERICAN ROCKET SOCIETY

IT PROBABLY just isn't possible for ARS Annual Meetings to follow a geometric expansion curve indefinitely, but it certainly looks as if the 13th Annual Meeting will make the necessary jump in the attendance abscissa to stay on the curve.

This year's meeting, to be held Nov. 17–21 at the Hotel Statler in New York, will be our first solo. It will mark the first time ARS members will not have to wend their way through congregations of boiler and railroad engineers from ASME to get to our own sessions.

New York's Hotel Statler, Scene of the ARS 13th Annual Meeting Nov. 17–21.

There is considerable nostalgia about leaving the ASME, of course. We greatly enjoyed their companionship, and we're everlastingly grateful for the room they made for us, which, it must be said, was not without considerable sacrifice on their part. However, ASME also recognizes the impossibility of combining the meetings of the two Societies in the same hotel nowadays, and so we're on our own.

The program for this meeting reflects the fact that the technical committees are getting stronger all the time. The Society is much indebted to the chairmen and the members of these committees for organizing the fine sessions described in the program below. Greatest single contribution was that of Howard S. Seifert, indefatigable Program Chairman and therefore coordinator of the entire program not only for this year's Annual Meeting, but for all National Meetings held by the Society during 1958. This was a behemoth job, and it was done magnificently.

Lineup of Sessions Impressive

Not only is the lineup of sessions a very impressive one, once again running the gamut of disciplines the ARS serves to unify in the common cause of space flight, but the social program as well. Outstanding speakers like Hugh Dryden, Roy W. Johnson and Simon Ramo are an extremely important part of any such gathering as this, which is expected to attract some 4000 engineers and scientists to the Statler during the five-day meeting period.

For the second year in a row, there will be a Section Delegates Conference. The spirit of exchange of ideas and gripes at last year's session

seems to indicate the Conference will be a fixture at future Annual Meetings. Also, for the second time, we will have an Eastern Regional Student Conference. The caliber of papers for the Conference appears to be very high, and it too is expected to draw a large attendance.

Feature event of the week's program will, of course, be the Honors Night Dinner. And this year, perhaps more than in any other previous year, the field of space flight takes on a sharper perspective, making the awards more meaningful than ever. When Richard Canright of ARPA (on loan from Douglas) receives the Robert H. Goddard Memorial Award, for example, the audience and the public will have a greater appreciation of what the award means because of the outstanding successes of satellite programs in the past year.

The same applies for the Hickman Award to Barnet Adelman of Ramo-Wooldridge; the James H. Wyld Award to Gen. Holger N. Toftoy of Redstone Arsenal; the G. Edward Pendray Award to Homer E. Newell of the Naval Research Laboratory; and the ARS Astronautics Award, which this year will go posthumously to the late Capt. Iven C. Kincheloe Jr.

Fellow Memberships Increased

In recognition of the expansion of the field, the number of fellow memberships has been increased to 12, and we are very proud of the outstanding dozen to be so honored. Fellow memberships will go to Brig. Gen. Homer Boushey, USAF Director of Advanced Technology; C. T. Draper, Massachusetts Institute of Technology; Herbert Friedman, Naval Research Laboratory; R. D. Gompertz, General Electric Co.; Robert Gross, Fairchild Engine Div.; Dan Kimball, Aerojet-General Corp.; Antoni K. Oppenheim, University of California; Admiral W. F. Raborn, U.S. Navy Bureau of Ordnance; Louis Ridenour, Lockheed Missile Systems Div.; Abe Silverstein, National Aeronautics and Space Administration; Ernst Stuhlinger, Army Ballistic Missile Agency; and James W. Wheeler, Sperry Gyroscope Co.

Finally, the Second Annual ARS Astronautical Exposition, taking up some 16,000 square feet and displaying models of space vehicles, rockets, guided missiles and related components and equipment, will create an atmosphere of technical progress the likes of which the staid old Hotel Statler has never seen.

The complete program for the meeting follows.

ARS Annual Meeting

Hotel Statler

New York City

November 17-21, 1958

Monday, November 17

9:30 a.m. **Terrace Room East**

PROPELLANTS

Chairman: Alexis W. Lemmon Jr., Chemical Engineering Research, Battelle Institute, Columbus, Ohio.

Vice-Chairman: Charles Marsel, Dept. of Chemical Engineering, New York University, New York, N.Y.

✦A Rational Approach to High-Performance Rocket Injector Design, I. J. Weisenberg, Reaction Motors Div., Thiokol Chemical Corp., Denville, N.J. (674-58)

✦The Vaporization of Propellants in Rocket Engines, Richard J. Priem and Marcus F. Heidman, NASA Lewis Flight Propulsion Lab., Cleveland, Ohio. (675-58)

✦Vaporization Rate Limited Combustion in Bipropellant Rocket Chambers, E. Mayer, Rocketdyne, Canoga Park, Calif. (676-58)

✦A Study of Combustible Mixture Formation with Liquid Fuels, Glendon Benson, M. M. El-Wakil, P. S. Myers, O. A. Uyehara, Dept. of Mechanical Engineering, Univ. of Wisconsin, Madison, Wis. (677-58)

9:30 a.m. **Sky Top**

PSYCHOPHYSIOLOGY

Chairman: Capt. George E. Ruff, USAF (MC), Aero Medical Lab., WADC, Wright-Patterson, AFB, Ohio.

Vice-Chairman: John H. Heller, New England Institute for Medical Research, Ridgefield, Conn.

✦Psychophysiological Aspects of the Man High Experiment, Lt. Col. David G. Simons, Aero Medical Field Lab., Holloman AFB, N. M. (678-58)

✦Application of a New Technique for Recording Skin Resistance Changes, E. Z. Levy, G. E. Ruff, V. H. Thaler, WADC, Wright-Patterson AFB, Ohio. (679-58)

✦Modifiability of Day-Night Cycling, George T. Hauty, School of Aviation Medicine, Randolph AFB, Tex. (680-58)

✦Psychophysiological Aspects of a Multiple Crew Compartment Study, Capt. C. F. Gell, Office of Naval Research, Washington, D. C. (681-58)

✦Measurement of Human Adaptation to Stressful Environments, Lt. Col. Paul B. Yessler, U.S.A. Medical Corps, Walter Reed Army Institute of Research, Washington, D.C. (682-58)

✦The Arousal Curve of Skin Resistance,

Sanford I. Cohen, Dept. of Psychiatry, Duke Univ., Durham, N.C. (683-58)

✦The Electroencephalogram as a State of Consciousness Indicator under Balloon Flight Conditions, Neil Burch, Dept. of Psychiatry, Baylor Univ. School of Medicine, Houston, Tex. (685-58)

12:00 Noon **Gold Ballroom**

ARS SECTION LUNCHEON

Presiding: George P. Sutton, President, AMERICAN ROCKET SOCIETY.

Brief reports from all ARS Sections will be delivered by the Section Presidents.

2:30 p.m. **Terrace Room East**

COMBUSTION

Chairman: Ali Bulent Cambel, Northwestern Univ., Evanston, Ill.

Vice-Chairman: Robert A. Gross, Fairchild Engine Div., Deer Park, N.Y.

✦Combustion Research—Whence and Whither, John B. Fenn, Project Squid, Princeton Univ., Princeton, N.J. (686-58)

✦Correlation and Prediction of Flame Properties, Melvin Gerstein, Lewis Flight Propulsion Lab., NASA, Cleveland, Ohio. (687-58)

✦Recent Advances in Gaseous Detonation, Robert A. Gross, Fairchild Engine Div., Deer Park, N.Y. and A. K. Oppenheim, Univ. of California, Berkeley, Calif. (688-58)

2:30 p.m. **Pennsylvania Room**

SECTION DELEGATES CONFERENCE

2:30 p.m. **Sky Top**

NUCLEAR PROPULSION

Chairman: Col. Jack L. Armstrong, Aircraft Reactor Branch, AEC, Germantown, Md.

Vice-Chairman: Frank Rom, Lewis Flight Propulsion Lab., NASA, Cleveland, Ohio.

✦Nuclear Rocket Propulsion Program at Los Alamos, Raemer E. Schreiber, Los Alamos Scientific Lab., Los Alamos, N.M. (689-58)

✦Some Boundary Conditions for the Use of Nuclear Energy in Rocket Propulsion, Robert W. Bussard, N Division, Los Alamos Scientific Lab., Los Alamos, N.M. (690-58)

✦Optimum Thrust Programming of Nuclear Rockets, Chiao J. Wang, Herbert R. Lawrence and George W. Anthony, Space Technology Lab., Ramo-Wooldridge Corp., Los Angeles, Calif. (691-58)

✦Design Considerations for Nuclear Rocket Test Stands, Sidney G. Rumbold, Rover Project, Aerojet-General Corp., Azusa, Calif. (692-58)

✦Dynamic Analysis of a Nuclear Rocket Engine System, Bernard Ross Felix, Nuclear Propulsion Systems, Advanced Design Section, Rocketdyne, Canoga Park, Calif. (693-58)

4:30 p.m. **Gold Ballroom**

ANNUAL ARS BUSINESS MEETING

Tuesday, November 18

9:15 a.m. **Terrace Room East**

SEALED CABINS

Chairman: Eugene B. Konecci, Douglas Aircraft Co., Tulsa, Okla.

Vice-Chairman: Brig. Gen. Don Flickinger, Headquarters, ARDC, Andrews AFB, Washington, D.C.

✦Navy Interests in Sealed Cabins, Malcolm D. Ross, Office of Naval Research, Washington, D.C. (694-58)

✦Sealed Cabins for Life Satellites, Lt. Col. David G. Simons and Capt. Eli L. Bleeding Jr., Air Force Missile Development Center, Holloman AFB, N.M. (695-58)

✦Sealed Cabins: Advanced Research Projects Agency Views, Richard D. Holbrook, Advanced Research Projects Agency, Washington, D.C. (696-58)

✦Sealed Cabin Requirements for Nonmilitary Missions, Max M. Faget and C. W. Mathews, Langley Aeronautical Lab., NASA, Langley Field, Va. (697-58)

✦Sealed Cabins: Area of Indecision, Irwin Cooper, The Rand Corp., Santa Monica, Calif. (698-58)

✦Climatic and Structural Aspects of Sealed Cabins, F. L. Dickey and G. H. Knipp, Douglas Aircraft Co., Tulsa, Okla. (699-58)

✦Accelerations of Space Flight, Col. John P. Stapp, USAF (MC), Wright-Patterson AFB, Ohio. (700-58)

✦Sealed Cabins: Research Program, Otto Winzen, Winzen Research, Inc., Minneapolis, Minn.

✦Space Cabin Requirements As Seen by Subjects in the Space Cabin Simulator, Capt. Willard R. Hawkins, School of Aviation Medicine, Randolph AFB, Tex. (702-58)

✦Psychological Aspects of Sealed Cabins, Arnold Small, Convair, San Diego, Calif. (703-58)

✦Biothermal Aspects of Re-entry from Extra Atmosphere Flight, Earl T. Carter, Ohio State Univ., Columbus, Ohio and M. W. Jack Bell, North American Aviation, Inc. (704-58)

9:30 a.m. **Sky Top**

RAMJETS AND MIXED CYCLE ENGINES (Confidential)

Sponsored by Army Ballistic Missile Agency. Attendance limited to first 500 whose clearance forms are processed.

Chairman: Frank I. Tanczos, Bureau of Ordnance, Washington, D.C.

Vice-Chairman: Benson E. Gammon, Headquarters, NASA, Washington, D.C.

✦Air Turborocket Developments, William N. Gilmer, Experiment, Inc., Richmond, Va.

✦External Burning Ramjets, Gordon L. Dugger, Louis Monchick and R. H. Cramer, Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

✦Solid Fuel Ramjet Developments, H. Powell Jenkins Jr., Naval Ordnance Test Station, China Lake, Calif.

✦Advanced Experimental Ramjets, Howard N. McFarland, Marquardt Aircraft Co., Van Nuys, Calif.

12:00 Noon **Gold Ballroom**

LUNCHEON

Speaker: Hugh L. Dryden, Deputy Administrator, National Aeronautics and Space Administration.

2:30 p.m. **Terrace Room East**

MAGNETOHYDRODYNAMICS

Chairman: Rudolf X. Meyer, Ramo-Wooldridge Corp., Los Angeles, Calif.

Vice-Chairman: Allen E. Fuhs, Northwestern Univ., Evanston, Ill.

✦General Behavior of Hydromagnetic Fluids, Russell M. Kulstrud, Project Matterhorn, Princeton Univ., Princeton, N.J. (705-58)

✦Aerothermodynamic and Electrical Properties of Some Gas Mixtures to Mach 20, W. Chinitz, L. Eisen and R. Gross, Fairchild Engine Div., Deer Park, N.Y. (706-58)

✦Experimental Magneto-Aerodynamics, Richard W. Zeimer, Ramo-Wooldridge Corp. Los Angeles, Calif. (707-58)

✦Preliminary Studies on Electrical Propulsion Systems for Space Travel, Robert Fox, Univ. of California, Radiation Lab., Livermore, Calif. (708-58)

✦Magnetohydrodynamics In Aeronautics, W. R. Sears, School of Aeronautical Engineering, Cornell Univ., Ithaca, N.Y. (709-58)

2:30 p.m. **Sky Top**

UTILITY AND LAW IN SPACE FLIGHT

Chairman: William H. Dorrance, Convair, San Diego, Calif.

Vice-Chairman: Philip L. Rountree, Republic Aviation Corp., Mineola, N.Y.

✦Commercial Rocket Airplane: A Connecting Link to Manned Space Flight, Robert A. Cornog, Space Technology Labs., Hawthorne, Calif. (710-58)

✦The Geodetic Satellite, Robert P. Haviland, General Electric Co., Philadelphia, Pa. (711-58)

✦The Orbital Post Office, Sidney Metzger, RCA Astro-Electronic Products Dept., Princeton, N.J. (712-58)

✦Space Law: Recent Practical Achievements, Andrew G. Haley, Haley, Wollenberg & Kenehan, Washington, D.C. (714-58)

4:30 p.m. **Sky Top**

THOR-ABLE

✦A Preliminary Experiment with Recoverable Biological Payloads in Ballistic Rockets —Project MIA, F. L. Van Der Wal and W. D. Young, Space Technology Labs., Los Angeles, Calif. (715-58)

8:00 p.m. **Sky Top**

NEW YORK SECTION FILM NIGHT

Presiding: Leonard S. Wiener, President, New York Section, ARS.

Films to be shown: Man in Space, Into the Yonder, Nautilus Submarine, The Moon, Mars, X-15.

Wednesday, November 19

9:30 a.m. **Terrace Room East**

RESEARCH ROCKET VEHICLES

Chairman: Louis Ridenour, Lockheed Missile Systems Division, Sunnyvale, Calif.

Vice-Chairman: Rudolf Stanpel, Army Signal R & D Lab., Fort Monmouth, N.J.

✦Lockheed X-17 Test Vehicle and Its Applications, Ronald Smelt, Lockheed Missile Systems Division, Sunnyvale, Calif. (716-58)

✦Farside Rocket Research Program, Herbert L. Karsch, Aeronutronic Systems, Inc., Glendale, Calif. (717-58)

✦Explorer Rocket Research Program, Geoffry Robillard, Solid Rockets Section, Jet Propulsion Lab., Pasadena, Calif. (718-58)

✦Vanguard Research Rocket Program, Milton Rosen, Naval Research Lab., Washington 25, D.C. (719-58)

✦NASA Research Rocket Program, A. O. Tischler, NASA, Cleveland, Ohio. (720-58)

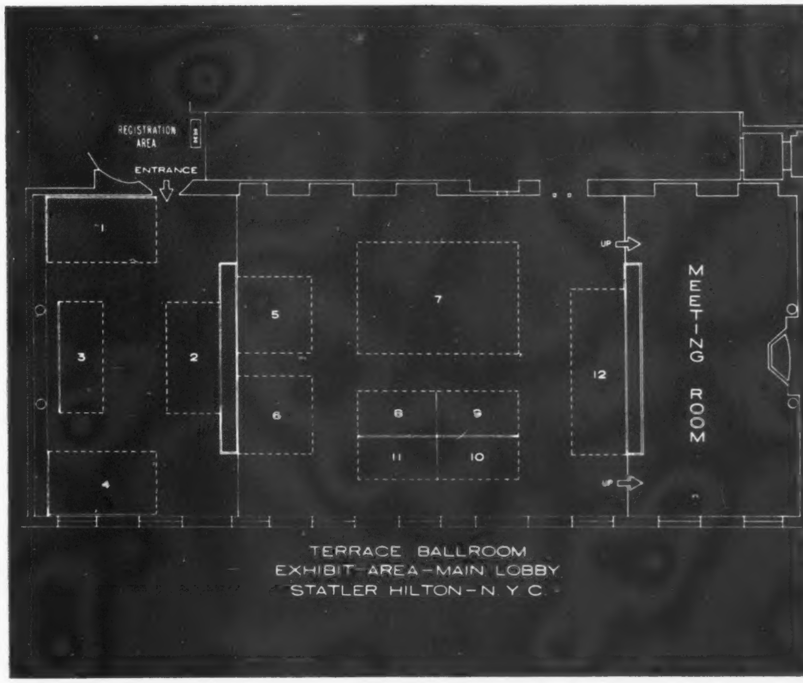
ARS ASTRONAUTICAL EXPOSITION

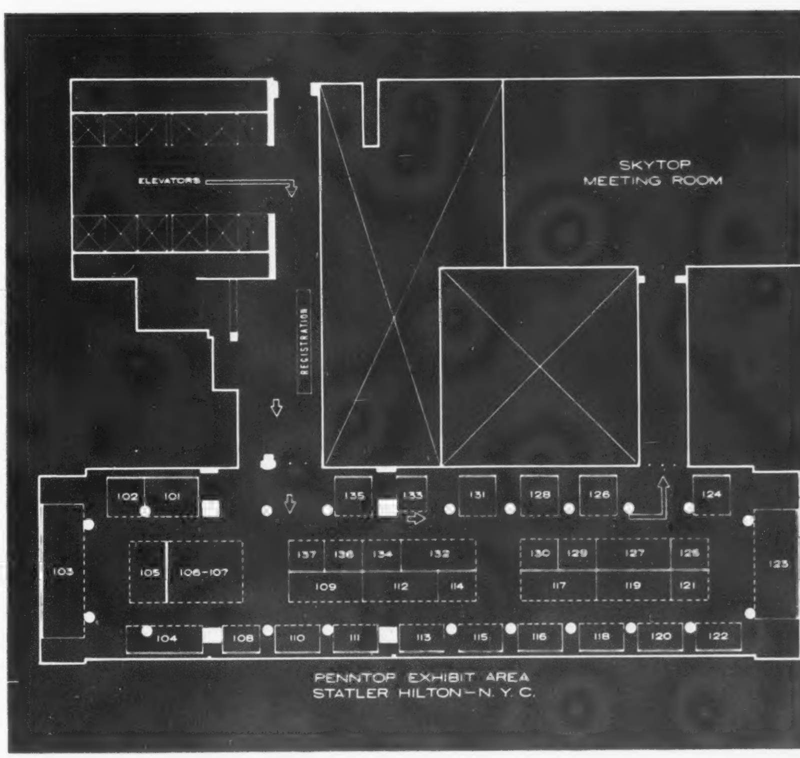
TERRACE BALLROOM

Aeronutronic Systems, Inc.
Atlantic Research Corp.
Callery Chemical Co.
Convair Div. of General Dynamics Corp.
Data-Control Systems, Inc.
Douglas Aircraft Co., Inc.
Ford Instrument Co.
Haveg Industries
International Telephone & Telegraph Corp.
Lukens Steel Co.
Marquardt Aircraft Co.
Raytheon Mfg. Co.
Royal McBee Corp.
(Royal Precision Co.)
Thiokol Chemical Corp.
Thompson Products, Inc.

PENNTOP

Acoustica Associates, Inc.
Aerojet-General Corp.
Aeroquip Corp.
Aeroquip Corp.–Marman Div.
Allied Chemical Corp.
Beckman & Whitley, Inc.
Bell Aircraft Corp.
Blaw-Knox Co.
Cannon Electric Co.
Chiksan Co.
Clemco Aero Products Inc.
Conover-Mast Publications
Diversey Engineering Co.
Food Machinery Co.
Garrett Corp.–AiResearch Mfg. Div.
General Electric Co.
General Electric Co.–Rocket Engine Section
General Electric Co.—Specialty Heating Products Section
Grumman Aircraft Corp.
Holex Inc.
Hoover Tool & Die Co.
Walter Kidde & Co., Inc.
Linde Co. Div. of Union Carbide Corp.
Lockheed Missile Systems Div.
McCormick Selph Associates
The Martin Co.
Minnesota Mining & Mfg. Co.
North American Aviation, Inc.–Autonetics Div.
North American Aviation, Inc.—Rocketdyne Div.
Parker Seal Co.
Perkin-Elmer Corp.
Permanent Filter Corp.
Shell Oil Co.
Westinghouse Air Arm Div.
E. B. Wiggins Oil Tool Co., Inc.
John Wiley & Sons, Inc.
Wyman-Gordon Co.





AWARD WINNERS

Left to right: R. B. Canright, ARPA, Goddard Award; Maj. Gen. H. N. Toftoy, Redstone Arsenal, James H. Wyld Award; Homer E. Newell Jr., Naval Research Laboratory, Pendray Award; and the late Capt. Iven C. Kincheloe Jr., ARS Astronautics Award. Photo of Barnet Adelman, Space Technology Laboratories, winner of the Hickman Award, was not available.

9:30 a.m. — **Sky Top**

U.S. SPACE CAPABILITY (Secret)

Sponsored by Army Ballistic Missile Agency. Attendance limited to first 500 whose clearance forms are processed.

Co-Chairman: Capt. Robert C. Truax, Advanced Research Projects Agency.
Co-Chairman: Richard W. Porter, General Electric Co., New York, N.Y.

Session will consist of discussions by the following representatives of agencies responsible for the position and plans of the U.S. in the field of space flight: Col. John L. Martin Jr., Air Force Directorate of Advance Technology; Rear Adm. John T. Hayward, Office of Chief of Naval Operations; Lt. Col. Glenn Crane, Ordnance Missile Command; Abe Silverstein, National Aeronautics and Space Administration; David A. Young, Advanced Research Projects Agency.

A presentation by each speaker will be followed by a roundtable discussion and questions from the floor.

12:00 Noon — **Gold Ballroom**

LUNCHEON

Speaker: Roy W. Johnson, Director, Advanced Research Projects Agency.

2:30 p.m. — **Terrace Room East**

SPACE FLIGHT OPERATIONS

Chairman: Robert A. Cornog, Space Technology Labs., Hawthorne, Calif.
Vice-Chairman: Joseph G. Gavin Jr., Grumman Aircraft Engineering Corp., Bethpage, N.Y.

✦Reduction of Flight Time and Propellant Requirements of Satellites with Electric Propulsion by the Use of Stored Electrical Energy, Morton Camac, AVCO Research Lab., Everett, Mass. (721-58)

✦A Unified Analytical Description of Satellite Attitude Motions, Robert Roberson, Autonetics, North American Aviation, Inc., Downey, Calif. (722-58)

✦Composite Trajectories Yielding Maximum Coasting Apogee Velocity, Stanley Ross, Lockheed Missile Systems Div., Palo Alto, Calif. (723-58)

✦Electric Arc Heaters for Re-entry Simulation and Space Propulsion, T. R. Brogan, AVCO Research Lab., Everett, Mass. (724-58)

2:30 p.m. — **Sky Top**

GUIDANCE (Secret)

Sponsored by Army Ballistic Missile Agency. Attendance limited to first 500 whose clearance forms are processed.

Chairman: Charles J. Mundo, Arma Div., American Bosch Arma Corp., Garden City, N.Y.
Vice-Chairman: William E. Frye, Lockheed Missile Systems Div., Palo Alto, Calif.

✦The Delta Minimum Inertial Guidance Scheme, Walter Haeussermann, Army Ballistic Missile Agency, Redstone Arsenal, Ala.

✦Techniques of Indication and Control for Guidance of Ballistic Missiles, Elmer T. Frye and Wallace Vander Velde, Instrumentation Lab., MIT, Cambridge, Mass.

✦System Considerations in Determining Hardware Configurations for ICBM Inertial Guidance, Bernard Litman, Arma Div., American Bosch Arma Corp., Garden City, N.Y.

✦BTL Radio Inertial Guidance System for ICBM, Joseph F. Shea, Bell Telephone Labs., Whippany, N.J.

✦Very Long Range Tracking System, E. King Stodola, Reeves Instrument Co., Garden City, N.Y.

7:00 p.m. — **Grand Ballroom**

HONORS NIGHT DINNER

Presiding: George P. Sutton, President, American Rocket Society.
Speaker: To Be Announced
Awards: Robert H. Goddard Memorial Award; C. N. Hickman Award; G. Edward Pendray Award; James H. Wyld Memorial Award; ARS Astronautics Award; ARS Chrysler Corporation Student Award; Fellow Membership Presentations.

Thursday, November 20

9:30 a.m. — **Terrace Room East**

MISSILE CONTROLS

Chairman: Theodore K. Steele, Bulova Research and Development Lab., Inc., Woodside, N.Y.
Vice Chairman: W. H. Thatcher, Bell Telephone Labs., Whippany, N. J.

✦Missile Control Systems, D. T. Sigley, W. Hostetler and E. W. Ford, Firestone Tire & Rubber Co., Los Angeles, Calif. (725-58)

✦An Approach to Predetermination of Reliability, P. F. Winternitz and L. V. Iaralballa, New York Univ., New York, N.Y. and W. B. Payne, Curtiss-Wright Corp., Wood Ridge, N.J. (726-58)

✦A Servo System for an Air Bearing Gyro Stabilized Platform, R. C. Martin, Army Ordnance Missile Command, Redstone Arsenal, Ala. (727-58)

✦Matching Auxiliary Power Supplies with Missile Control Requirements, H. J. Howard, Vickers, Inc., Torrance, Calif. (728-58)

9:30 a.m. **Sky Top**

LARGE LIQUID ROCKETS (Confidential)

Sponsored by Army Ballistic Missile Agency. Attendance limited to first 500 whose clearance forms are processed.

Chairman: Robertson Youngquist, Advanced Research Projects Agency, Washington, D.C.

Vice-Chairman: Delacy F. Ferris, Reaction Motors Div., Thiokol Chemical Corp., Denville, N.J.

✦The Bomarc Development Story, George W. Hettrick, Boeing Airplane Co., Pilotless Aircraft Div., Seattle, Wash.

✦High Thrust Liquid Rocket Engines, J. C. Moise, Aerojet-General Corp., Sacramento, Calif.

✦Development of the Rocket Engine for the Atlas Missile, Norman C. Reuel, Rocketdyne, North American Aviation, Inc., Canoga Park, Calif.

✦The Multi-Million Pound Thrust Liquid Propellant Rocket Engine, K. Berman, General Electric Co., Malta Test Station, Ballston Spa, N.Y.

✦Space Flight and Intercontinental Missile Capabilities of Existing or Programmed Rocket Propulsion Systems, M. Goldsmith and E. C. Heffern, The Rand Corp., Santa Monica, Calif.

2:00 Noon **Georgian Room**

LUNCHEON

Speaker: Simon Ramo, President, Space Technology Labs.

2:30 p.m. **Terrace Room East**

STRUCTURES

Chairman: Raymond L. Bisplinghoff, Massachusetts Institute of Technology, Cambridge, Mass.

Vice-Chairman: Samuel Levy, Missile and Ordnance Systems Dept., General Electric Co., Philadelphia, Pa.

✦Some Structural Aspects of Orbital Flight, George Gerard, College of Engineering, New York Univ., University Heights, N.Y. (729-58)

✦Brazed High Temperature Sandwich Developments for Use in Rocket Structures, Richard S. Mueller and George D. Cremer, Solar Aircraft Co., San Diego, Calif. (730-58)

✦Buckling of Unstiffened Thin Walled Cylindrical Shells Subjected to Various Loading Conditions With and Without Internal Pressure, Bertram Klein, Convair-Astronautics, San Diego, Calif. (731-58)

✦Structural Considerations of Manned Space Vehicles, Anthony P. Coppa, Missile and Ordnance Systems Dept., General Electric Co., Philadelphia, Pa. (732-58)

✦Structures for Space Craft, Paul E. Sandorff, Massachusetts Institute of Technology, Cambridge, Mass. (733-58)

2:30 p.m. **Sky Top**

LARGE SOLID ROCKETS (Confidential)

Sponsored by Army Ballistic Missile Agency. Attendance limited to first 500 whose clearance forms are processed.

Chairman: John Calathes, The Martin Co., Baltimore, Md.

Vice-Chairman: Irvin Glassman, Princeton Univ., Princeton, N.J.

✦Development of the Nike-Zeus Sustainer, Earl Anderson, Grand Central Rocket Co., Redlands, Calif.

✦End-Burning Charges for Large Solid Propellant Rocket Motors, M. L. Rice, P. S. Shane and R. W. Van De Vreed, Atlantic Research Corp., Alexandria, Va.

✦Development of the XM-34 Solid Propellant Booster and its Application to F-100 Zero-Length Takeoffs, James A. Reid, Astrodyne, Inc., McGregor, Tex.

✦Advances in the State of the Art of Large Solid Propellant Rocketry, Robert E. Davis, Aerojet-General Corp., Sacramento, Calif.

Friday, November 21

9:30 a.m. **Sky Top**

SECOND ANNUAL ARS EASTERN REGIONAL STUDENT CONFERENCE

Papers will consist of top entrees in Chrysler Award competition, in addition to Steam Rocket by R. C. Truax.

✦General Technical Report on the Experimental Liquid-Propelled Rocket DREX-3, Chuck Meldrun, Univ. of Detroit, Detroit, Mich.

✦Ignition of Several Metals in Fluorine, Thomas W. Godwin and Carl F. Lorenzo, Fenn College, Cleveland, Ohio.

✦Inertial Guidance, Bert W. Hilburger, Univ. of Michigan, Ann Arbor, Mich.

✦Some Unique Problems Associated with Nuclear Propulsion, David L. Clingman, Purdue Univ., W. Lafayette, Ind.

✦The Use of Louvres in the Radiative Heating and Cooling of a Space Vehicle, Dorian J. Swartz, Univ. of California, Los Angeles, Calif.

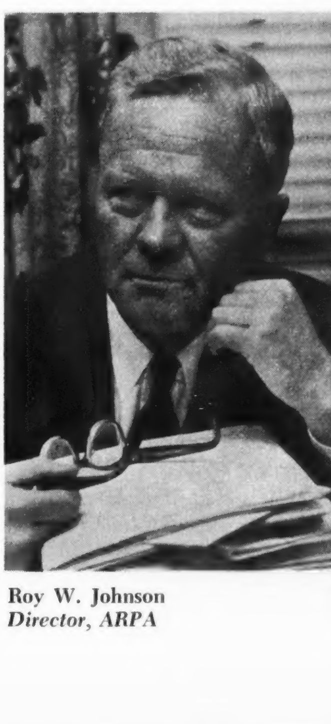
✦Maximum Flight Performance of Rocket Propellant Mixtures, Ahmed N. Hosny, Univ. of Texas, Austin, Tex.

12:00 Noon

LUNCHEON

Speaker: George P. Sutton, President, American Rocket Society.

LUNCHEON SPEAKERS



Roy W. Johnson
Director, ARPA

Hugh L. Dryden
Deputy Administrator, NASA

Simon Ramo
President, Space Technology Laboratories

1958—A year of growth for ARS

Jump in membership to over 12,000, vastly increased member services and stable financial position mark the Society's most successful year

By George P. Sutton

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASS.

PRESIDENT, AMERICAN ROCKET SOCIETY

Last month, George Sutton began a one-year leave of absence from his position as Manager of Advance Design for Rocketdyne to spend the 1958–59 academic year as Hunsaker Professor of Aeronautical Engineering at MIT. The 1958 President of ARS began his career in rocketry in 1943 after receiving his M.S. in mechanical engineering from Cal Tech. He joined a group of North American Aviation missile scientists in 1946 as a research engineer, subsequently holding prominent roles in that group's development of high thrust rocket propulsion systems. Author of many technical papers, he was the recipient of the ARS G. Edward Pendray Award in 1951 for writing "Rocket Propulsion Elements," now one of the standard texts in the field. He has been chairman of several ARS committees and has been a member of the ARS Board since 1954.

CURRENT INTEREST in astronautics and its growing importance on the world scene have inevitably led to changes in the minds of men. Space has become the new frontier, reawakening man's spirit of adventure and creating a host of exciting new goals and aspirations. The challenge of space has also brought with it a realization of how much remains to be done before interstellar vehicles are commonplace and man roams freely around this great universe.

Evidence that in this country the message long preached by the rocket and space flight pioneers (and the ARS) has at last gotten through to the powers that be, albeit with an assist from their fellow scientists in the Soviet Union, lies in the establishment of NASA and ARPA and in the great interest currently being displayed in astronautics by both industry and the military.

History has taught us, however, that flurries of interest of this type are all too often transitory, subject, as they are, to the shifting winds of military necessity and the vagaries of international politics. It is to be hoped that these first important steps are merely the prelude to formal establishment of space conquest as a major aim of national, as well as international, policy.

This is no easy matter, for space conquest will necessitate long-term and continuous funding, which means educating the public to the point where this need is fully understood and firm support of astronautical projects is forthcoming.

One other avenue of approach also is worthy of mention, and that

ARS Growth, 1956–1958

	1956	1957	1958(est.)
Members	4707	7343	12,200
Corporate Members	75	95	150
Pages Published	1152	1786	2080
Papers Presented at National Meetings	93	172	203
Headquarters Staff	7	24	24
Total Income	$252,000	$453,000	$650,000
Sections	26	34	41
Student Chapters	4	8	15

is the field of international cooperation in major space flight projects. The past year has also marked the first serious efforts toward this end, both in the UN and in the IAF.

It is somehow fitting that 1958 should also be the year of greatest growth for the American Rocket Society, for ARS was for years kept alive by a relative handful of hardy souls with a profound belief that man would reach the stars and that, when he went, he would be traveling in a rocket propulsion vehicle.

It is therefore heartening to note that in 1958 ARS membership jumped from 7000 to more than 12,000; that ARS corporate members increased from 95 to 150 despite an increase in corporate dues; that the number of ARS Sections and Student Chapters has grown; and that the Society has achieved financial stability despite publication of a new monthly magazine and vastly increased member services.

While ARS has long been the world's leading engineering fraternity in the rocket, propulsion and space flight fields, never has its dominance been more clearly demonstrated. For example, it is today more than three times as large as its largest sister society, the British Interplanetary Society. The table of ARS growth on the opposite page will serve to indicate the tremendous strides the Society has made in the past two years.

Along with this growth has come a considerable increase in member services. Nowhere is this indicated more obviously than in the program for the 13th Annual Meeting this month. The meeting will be marked by more technical *sessions* (16) than the total number of *papers* presented at annual meetings no more than 10 years ago, and will attract an attendance of close to 4000, whereas an audience of 200 was considered outstanding not so long ago.

Represent Major Service to Members

There can be little doubt that the papers presented at these technical sessions represent one of the most important services ARS offers its members. They serve to keep members alerted to the ever-changing state of the art, and to disseminate data and information vital to continued forward progress in the many broad fields of ARS interest.

And the Annual Meeting is only one of four national meetings sponsored each year by the Society. The total number of papers presented at these meetings has risen from 93 to 203 in just two years, and continues to grow year by year.

In addition, through the network of regional sections and Student Chapters established at important centers of rocket and astronautical activity throughout the country, ARS members are provided with the opportunity to keep abreast of important developments on a month-to-month basis. At some 400 local meetings, ARS members have not only had a chance to hear discussions of interesting technical topics, but also have gotten together informally with members of other companies working in their own fields.

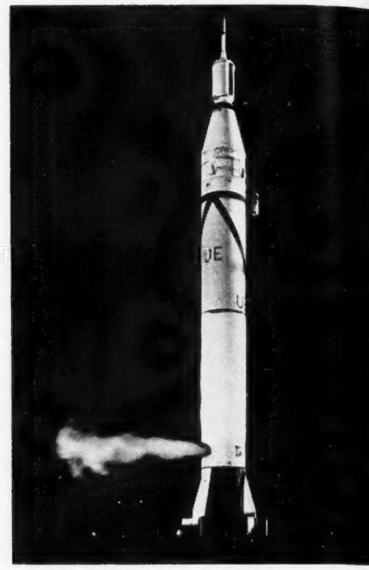
Hand-in-hand with ARS growth has gone the growth of its two monthly publications, Jet Propulsion and Astronautics. The improved financial position of the Society will in the near future permit gradual expansion of Jet Propulsion to a point where it will be able to publish many more technical papers than it can handle at the present time. Such expansion is vital to assure full coverage of the many broad areas of ARS interest. (continued on page 132)

ARS Section Presidents

Alabama—David H. Newby
Antelope Valley—Walter A. Detjen
Central California—E. O. Rolle
Central Colorado—Elliot Ring
Central Texas—C. H. Herty
Chicago—Stephen J. Fraenkel
Cleveland-Akron—Paul M. Ordin
Columbus—Loren E. Bollinger
Connecticut Valley—Charles H. King
Dayton—William J. Cushing
Detroit—Charles W. Tait
Florida—Capt. R. F. Sellars
Fort Wayne—Franklyn H. Brady
Holloman—Knox Millsaps
Indiana—Donald Emmons
Maryland—Samuel Fradin
National Capital—Robert L. Hirsch
New England—Lawrence Levy
New Mexico-West Texas—Keith E. Hennigh
New York—Leonard S. Wiener
Niagara Frontier—R. Dewey Rinehart
North Texas—Charles F. Crabtree
Northeastern New York—F. W. Crimp Jr.
N. California—E. A Quarterman
Pacific Northwest—G. Truxton Ringe
Philadelphia—Gerhard Barth-Wehrenalp
Princeton Group—Kimball P. Hall
Sacramento—Clair M. Beighley
St. Joseph Valley—J. J. Martin
St. Louis—P. W. Godfrey
San Diego—William H. Dorrance
Southern California—G. Daniel Brewer
Southern Ohio—S. N. Suciu
Twin Cities—T. F. Irvine
University Park—Thaddeus S. Merriman
Valley Forge—William L. Doyle
Wichita—P. Harvey Anselm

ARS Student Chapter Chairmen

Academy of Aeronautics—Felix R. Giacini
Boston University—Robert Johnson
Georgia Tech.—James C. Ludwig
N.Y.U.—Robert E. Huber
Parks College—James C. Morrison
Polytechnic Institute of Brooklyn—Fred L. Schuyler
Stevens Inst. of Tech.—Richard Nelson
University of Florida—Richard H. Jackson
University of Michigan—J. B. Bullock
University of Virginia—Charles S. Green III
University of Washington—Dennis Leigh
Wayne State University—Leroy Matthews



State of the Art, 1958

Space flight

By Krafft A. Ehricke

CONVAIR, A DIVISION OF GENERAL DYNAMICS CORP., SAN DIEGO, CALIF.

CHAIRMAN, ARS SPACE FLIGHT COMMITTEE

Krafft Ehricke, chairman of the ARS Space Flight Committee for the past two years, is now assistant to the chief engineer of Convair-Astronautics. After graduating as an aeronautical engineer in Berlin, Germany, he worked at Peenemuende during WW II on the V-2 project. After obtaining a Department of the Army contract in 1945, he worked from 1947 to 1950 as a research engineer on ramjet and rocket systems at Ft. Bliss, Tex. From 1950 to 1952 he headed the Gas Dynamics Section at Redstone Arsenal, and from 1952 to 1954 he was a preliminary design engineer with Bell Aircraft Corp. He joined Convair in 1954 as a design specialist, later heading the preliminary design and systems analysis group of the Astronautics Div. He was named to his present position last year.

THE YEAR following Sputnik I brought official recognition of the realities of space flight in the scientific, military and political plane. Legislation (see chronological rundown on page 49) and national organization gradually evolved for the purpose of immediate action in advancing U.S. space programs and for long-range planning, support and execution of space projects. Formed since February have been Senate and House committees on space and astronautics, the National Aeronautics and Space Council headed by the president, the Advanced Research Projects Agency (ARPA), the National Aeronautics and Space Administration (NASA) and, more recently, the 16-man Space Science Board of the National Academy of Sciences.

The practical execution of programs rests primarily with the armed services and the industry. Gradually, NASA will participate through in-house work in experimental development projects pertaining specifically to space, beyond what has already been done or initiated by NACA, especially in the field of hypersonic flight and high energy chemical propulsion. ARPA is exclusively an administrative, policy-making organization that relies on the armed services for the execution of authorized programs.

The goal of these groups will be to bring about a vigorous and successful space program through–

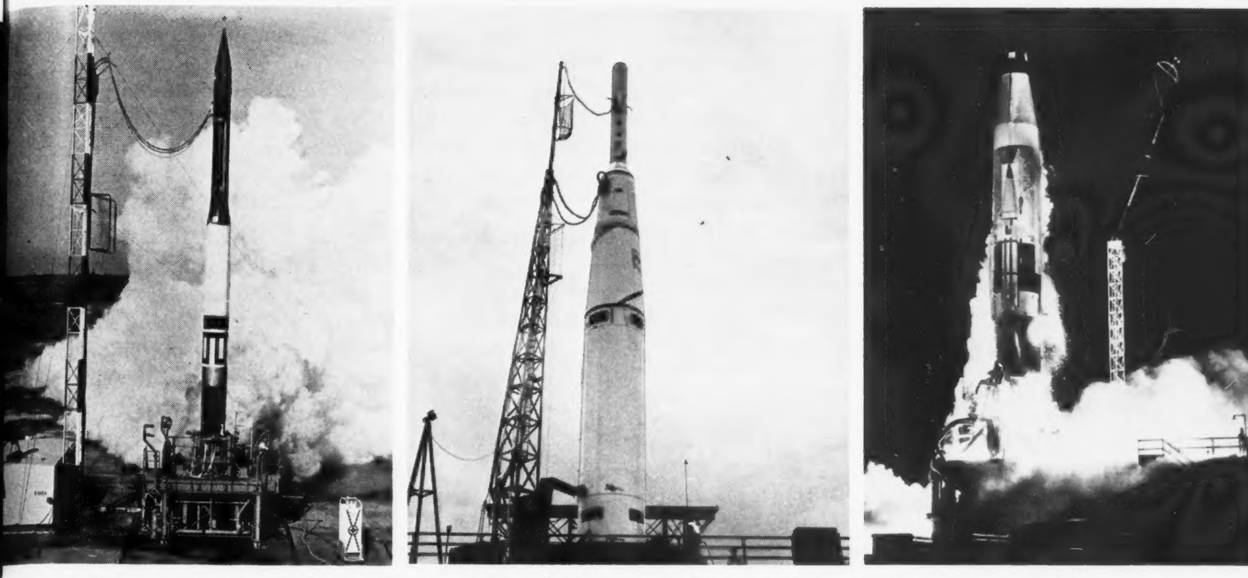
Recognition of the permanent importance of astronautics to the nation and to all mankind.

Consistent financial and political support.

Knowledgeable leadership and power of decision.

Teamwork and cooperation among our responsible space agencies, bringing to bear the scientific talent, technical knowhow and industrial management capability of the nation.

A number of missions into space have been flown this year. Most were satellite projects directed to terrestrial space, all less than one earth radius distant. The U.S. made no vertical firings to several thousand miles altitude, such as Project Farside last year. However, Russia conducted a number of successful high altitude flights with dogs, which were recovered satisfactorily. Britain has begun high altitude flights at the Woomera Range in Southwest Australia



Our first year of space flight saw these rockets make history: (left to right) Jupiter C, tuning up to deliver our first satellite into orbit Jan. 31; Vanguard, which put up a $3^1/_4$-lb satellite Mar. 17; Thor-Able lunar probe vehicle, which aimed for the moon but ended ingloriously Sept. 7; and Atlas, employing the most powerful booster yet developed in this country, taking off Aug. 28 under full thrust in the second of three consecutive successful free flights.

with its Black Knight rocket, one such rocket being fired successfully Sept. 7 and its nose cone recovered. The altitude obtained was not revealed, but the vehicle is supposed to be able to reach 300 to 400 miles. This is a step in Britain's development of a satellite vehicle and possibly of an intercontinental ballistic missile.

Redstone Will Continue To Be Used

The table on page 48 summarizes satellite firings so far in 1958. The reliable, well-developed Redstone vehicle, serving in modified form as a booster, proved its importance for this nation's first exploratory flights into space, and will continue to serve as a workhorse booster. The largest and technically most advanced satellite launched so far in 1958 is Sputnik III. Not only does it contain a large variety of measuring instruments, but it is also equipped with such advanced features as photosensitive albedo control for temperature regulation. No optical equipment has been mentioned. The irregular tumbling of the satellite appears to verify the assumption that Sputnik III is not a photosatellite.

In the re-entry field, additional experimental flights were made. Jupiter-C powered a full-size

Space Flight Accomplishments and Implications of Hardware Developed or in Development, 1958

		Mission Payload Capability (lb)						
Vehicles	Booster Thrust (lb)	Earth Orbital	Lunar Probe	Lunar Satellite	Lunar Landing	Venus/Mars	Intra-Mercurial Space (Solar Probe)	Trans-Martian Space (Asteroid Probe)
Juno I/Vanguard	Ten thousands	Tens	—	—	—	—	—	—
Juno II/Thor-Able (i.e. Jupiter and Thor with upper stages)	Some hundred thousand	Hundreds	Tens	Tens (temporary satellite)	—	Tens (with special modifications)	—	—
Atlas/Titan (with upper stages)	Several hundred thousand	Thousands	Thousands	Some thousand	Hundreds	Some thousand	Hundreds	Hundreds

Note: Data are approximate for security reasons.

IRBM nose cone 1500 n. mi, and the Thor-Able combination flew for the first time over the full ICBM range of 5500 n.mi. The tests were highly successful (notwithstanding the fact that the mice could not be found), and much useful data obtained. The development of the Jupiter and Thor IRBM's progressed satisfactorily. The fact that a total of five lunar firings are planned for the near future based on Jupiter and Thor bear witness to this fact.

Lunar Probe Vehicles

The most ambitious space project to date is the authorization for five launchings of interplanetary probes into the vicinity of the moon. Of these, three are based on a modified Thor-Able system, and two on a modified Jupiter system. The first of the three Thor-based launchings was attempted Aug. 17, but failed, apparently due to engine trouble in the booster. This is the kind of failure which certainly does not disprove the purpose of the mission nor of the principal capability to accomplish it. The Thor system uses the second and third stage of Vanguard as its second and third stage, and an additional stage for slowdown near the moon. The Jupiter system, Juno II, is based on the Jupiter IRBM, carrying at least three upper solid propellant stages of various cluster arrangements. The first Thor system carried equipment for taking and transmitting pictures from different sides, and especially the far side, of the moon.

To assure that the probe would stay long enough in the vicinity of the moon, it was to be slowed down by reverse thrust as it approached the moon. Because of limited accuracy and energy available, the resulting selenocentric orbit probably would have been a very elongated ellipse of somewhat arbitrary orientation of its major axis. If the ellipse was sufficiently elongated, the moon would not be able to hold its tiny satellite indefinitely, and a later conjunction of earth and sun (seen from the moon) would pull it back into a geocentric orbit.

The published reports on the Atlas vehicle show that this nation's ICBM effort has made considerable progress during this year. The Air Force–Convair–North American–General Electric team has proved that this vehicle, frequently underrated in the past, is worth the considerable effort spent on it. The remarkably smooth and successful test flights which recently culminated in three successive successful three- (CONTINUED ON PAGE 124)

Artificial Earth Satellites in Orbit—1958 (as of Sept. 15)

General Designation	Explorer I	Vanguard I	Explorer III	Sputnik III	Explorer IV
Astronomical code name	1958 α	1958 β	1958 γ	1958 δ	1958 ϵ
Launching date	Jan. 31	March 17	March 26	May 15	July 26
Total weight in orbit (lb)	30.8		31.0		34.43
Payload weight of satellite (lb)	18.13	3.26	18.33	2925	~21
Shape	Cone-cylinder	Spherical	Cone-cylinder	Conical	Cone-cylinder
Length	6.66 ft (total)		34 (sat.) + 46 (final st.) in	11 ft 5.6 in.	Like Explorer I
Diameter	6 in.	6 in.	6 in.	5.12 ft (base)	6 in.
Orbital period (min)	114.9	134	115.87	106	110.2
Perigee altitude (n mi.)	195.5	350.5	100.11	130	155
Apogee altitude (n. mi.)	1384	2140	1285	1085	1205
Orbital inclination (deg)	33.5				51
Radio frequency (mc)	108.00/108.03	108.00/108.03	108.00/108.03	20.005	108.00/108.03
Instrumentation or measurements	Micrometeorite erosion gauges. External temp. gauges (rear and front). Internal temp. gauge. Micrometeorite impact microphones. Cosmic ray counter.	Solar batteries for experimental purposes.	Micrometeorite erosion gauges. Cosmic ray counter (more expensive package than Explorer I) External temp. gauges. Playback recorder.	Pressure. Atmospheric composition. Concentration of positive ions. Electrical changes in satellite. Earth's magnetic field. Solar corpuscular radiation. Primary cosmic radiation. Distribution of protons & heavy nuclei in cosmic primaries. Micrometeorites. Temp. inside and outside satellite. Playback recorder.	Emphasis is on additional measurements of belt. Two Geiger counters measure radiation inside satellite, two scintillation detectors measure radiation outside satellite. Measuring range has been increased compared to earlier Explorers. System is capable of differentiating between various radiation energy levels by differences in shielding.

1958 Space Legislation Timetable

Feb. 6—Senate establishes Special Committee on Space and Astronautics with Majority Leader Lyndon B. Johnson (D. Texas) as chairman.

Feb. 7—Secretary of Defense Neil McElroy issues directive establishing Advanced Research Projects Agency (ARPA) with jurisdiction over all advanced research and development projects of Department of Defense. Roy Johnson is named head, assisted by Rear Adm. John E. Clark.

March 5—House establishes Select Committee on Astronautics and Space Exploration with Majority Leader John W. McCormack (D. Mass.) as chairman.

April 2—President Eisenhower asks Congress to establish National Aeronautics and Space Agency in special message. Draft of proposed legislation is submitted and referred by Speaker to House Space Committee.

April 14—McCormack introduces administration bill in House (H.R. 11881) and Johnson in Senate (S. 3609).

April 15–May 12—House committee holds public hearings on administration bill.

May 6–15—Senate committee holds public hearings on administration bill.

May 13—At direction of House committee, McCormack introduces House Concurrent Resolution 326 calling for the peaceful exploration of space.

May 21—House committee issues report to House on "The National Space Program." (House Report No. 1758).

May 23—House Foreign Affairs Committee approves House Concurrent Resolution 332 (revision of H. Conc. Res. 326). (House Report 1769).

May 24—House committee approves and reports to House H.R. 12575, a bill introduced the previous day by McCormack at the committee's direction. The bill establishes the National Aeronautics and Space Administration (NASA). (House Report 1770).

June 2—House adopts House Concurrent Resolution 332, the outer space peace resolution.

—House unanimously approves H.R. 12575, establishing NASA.

June 11—Senate committee reports out S. 3609.

June 16—Senate unanimously approves H.R. 12575, with text of S. 3609 substituted for House text. Bill sent to conference.

July 15—House and Senate conferees reach agreement on space agency legislation.

July 16—House and Senate adopt conference report on H.R. 12575.

July 21—House approves House Resolution 580, establishing 25-member standing committee on Science and Astronautics.

July 23—Senate approves House Concurrent Resolution 332, calling for peaceful exploration of space.

July 24—Senate establishes standing committee on Astronautics.

July 29—President signs H.R. 12575, establishing NASA. (Public Law 85–568).

July 31—Senate committee approves S. 4208, authorizing appropriation of $47,800,000 for NASA for fiscal 1959 for construction and facilities.

Aug. 1—Senate approves S. 4208.

—House committee approves H.R. 13619, companion bill to S. 4208, following public hearing.

Aug. 4—House approves S. 4208.

Aug. 9—President names T. Keith Glennan, president of Case Institute of Technology, as Administrator of NASA, and Hugh Dryden, director of the National Advisory Committtee for Aeronautics, as Deputy Administrator.

Aug. 13—Senate Appropriations Committee approves Supplemental Appropriation Bill (H.R. 13450), containing $75,000,000 in funds for NASA for fiscal 1959, a reduction of $50,000,000 from amount requested by the President.

Aug. 14—Senate space committee approves Glennan and Dryden nominations.

—President signs S. 4208, authorizing NASA construction appropriations (Public Law 85–657).

Aug. 15—Senate confirms Glennan and Dryden.

—Senate approves Supplemental Appropriation Bill, with $50,000,000 cut restored, along with amendment by Johnson requiring annual authorization in future before any funds can be appropriated for NASA.

Aug. 19—House and Senate conferees agree on $80,000,000 for NASA for fiscal 1959, along with Johnson rider. (House Report 2677.)

Aug. 20—House approves Supplemental Appropriation Bill conference report containing $80,000,000 in funds for NASA, rejects Johnson rider but agrees to one-year (fiscal 1960) authorization limitation.

Aug. 21—Senate approves conference report on Supplemental Appropriation Bill, including $80,000,000 in NASA funds, accepts House revision of Johnson rider. House approves conference report.

Aug. 24—Senate appoints new standing committee on Astronautics.

Aug. 27—President signs Supplemental Appropriation Bill (Public Law 85–766). Bill includes $80,000,000 for NASA for fiscal 1959, including $50,000,000 for research and development, $25,000,000 for construction and equipment, and $5,000,000 for salaries and expenses.

Sept. 4—President names Lt. Gen. James H. Doolittle, William A. M. Burden, Alan T. Waterman and Detlev T. Bronk to serve on the civilian space agency council, along with John Dulles, Neil McElroy, Keith Glennan and John A. McCone.

State of the Art, 1958

Liquid rockets

By Y. C. Lee

AEROJET-GENERAL CORP., AZUSA, CALIF.

CHAIRMAN, ARS LIQUID ROCKET COMMITTEE

Y. C. Lee directs Aerojet-General's advanced missile research and development in the fields of propulsion, high temperature materials, advanced systems studies, aerodynamics, combustion dynamics, applied mechanics, and classical and nuclear physics. After receiving a degree in aeronautical engineering from the California Institute of Technology in 1938, he joined Consolidated-Vultee, doing stress analysis on various military aircraft and aerodynamics engineering on Bumblebee and MX-774 projects. In 1947, he became a research associate at the University of Southern California's Mechanical Engineering Dept., working on supersonic wind tunnel design. Since joining Aerojet in 1949, he has done research on combustion stability in liquid propellant engines, high energy propellant combustion, free radical propulsion and electric propulsion systems.

THERE can be little question about the fact that the large liquid propellant rocket produced some potent arguments in its favor during 1958. The successful flight tests of the Jupiter and Thor IRBM's and Atlas ICBM, as well as the flights of the Jupiter-C, Thor-Able and Vanguard vehicles, clearly demonstrated the here-and-now of the liquid propellant long-range missile and satellite delivery system.

Moreover, recent AF and Army contracts for the development of liquid engines in the 1-million to 1.5-million-lb thrust class assure us that the technology already being put to use in such vehicles can be extended in the near future to provide propulsive power for our first manned space vehicles.

These events, anticipating a new cycle in the exploitation of the liquid engine, have again focused attention on the fundamentals of liquid rocketry. Part of the story lies in the propellants themselves, as discussed in the article by John Sloop on page 56. Another part is suggested by a recent announcement that high performance liquid rockets can be made self-contained and storable. It can be expected that means will also be found of storing cryogenic propellants in this manner with little loss from evaporation.

Chief Asset Lies in High Performance

Now let's take a look at the state of the art in liquid rockets from the standpoint of future missions.

The chief asset of the liquid engine lies in its high performance, stemming from a combination of high specific impulse and good mass ratio. The chart on page 51 gives some theoretical Isp values for typical liquid propellant combinations.

For the large rockets in demand today, specific impulse is the parameter which to a large degree determines overall system efficiency, payload size and gross takeoff weight. While arguments have been advanced that, since the overall density of liquid propellant combinations is not high, liquids are not especially advantageous, it can be shown that, for large booster rockets—say, in excess of 400,000-lb thrust, and operating for more than 100 sec—liquids are the only choice at present. This is especially true in the case of a multiple-stage, high payload, orbital mission, particularly if we think in terms of high performance liquids such as fluorine and hydrazine or lox and hydrogen.

Any discussion of the present state of the art of liquid rockets must take into account the physical properties of the propellants themselves, and especially of the oxidizers. The chart shown

Properties of Oxidizers

	Freezing Temp. (°F)	Normal Boiling Point (NBP)(°F)	Vapor Pressure at 68°F (PSIA)	Specific Gravity at 68°F	Toxicity (continuous exposure) (PPM)	Corrosion
Red Fuming Nitric Acid HNO_3 (15% NO_2)	−68	136	2.3	1.57	40	Corrosive inhibited with 1/2% HF
Nitrogen Tetroxide N_2O_4	11	72	13	1.44	12	Mild corrosive in presence of water
Chlorine Trifluoride ClF_3	−232	50	21	1.84	0.1	Mild
Oxygen O_2	−362	−297			Nontoxic	Noncorrosive
Fluorine F_2	−364	−305			3	Very Corrosive

above considers a group of oxidizers in terms of some of these properties–freezing temperature, boiling point, stability, corrosiveness, etc.

The chart indicates that, while most liquid oxidizers are stable and meet temperature requirements, they are in many instances also corrosive and relatively toxic. In addition, some oxidizers, such as liquid fluorine and lox, are liquified gases, which makes topping of propellant tanks during countdown a problem, while the extremely low temperatures required lead to sealing and material problems.

However, considerable progress has been made in the field of storable oxidizers, like nitric acid, nitrogen tetroxide and chlorine trifluoride, which do not present such problems. Also, such oxidizers are hypergolic with fuels like hydrazine and unsymmetrical dimethyl-hydrazine.

Because such propellants are hypergolic, storable and offer relatively high performance, liquid propellant combinations of this type (nitrogen tetroxide and hydrazine is an outstanding example) offer excellent possibilities for use in space missions.

Space mission studies, particularly those dealing with manned space flight, have indicated that, for structural as well as human factors reasons, constant-acceleration flight, rather than constant-thrust flight, is desirable. To achieve constant acceleration, a rocket must be throttleable, and here again the liquid rocket meets the requirements.

Must Deliver Thrust on Command

Furthermore, to achieve small trajectory corrections or overcome perturbations of a satellite orbit, it is necessary to have a rocket which can deliver the required thrust on command. Here, too, the liquid rocket can do the job best.

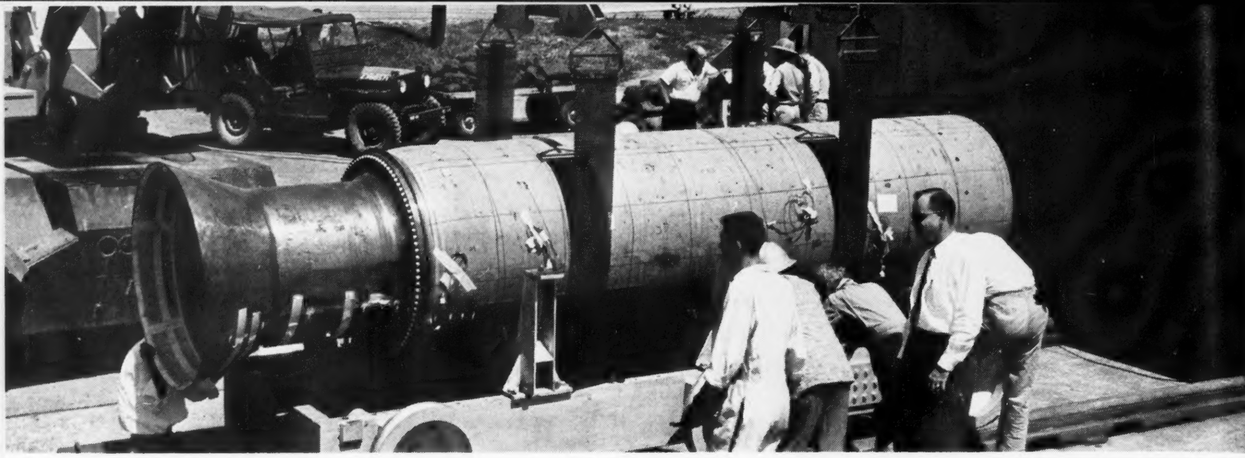
While there are no throttleable liquid rockets in current use, sufficient development work has been performed to date to indicate that a throttling range of 10 to 1 is feasible. During the past year, some of the work in this area has been applied in the field of rocket drones.

With a combination of throttling devices, such as multiple-stage injectors and nozzle plugs, continuous throttling with a wide range of thrust can be achieved.

While solid propellant composite grain configurations can provide a two-step operation similar to throttling for space missions, step-wise operation would not meet the need (CONTINUED ON PAGE 134)

Specific Impulse of Some Typical Liquid Propellants

Propellant Combinations	I_{sp} Range (sec)
Low energy monopropellants	160–190
Hydrazine	
Ethylene oxide	
Hydrogen peroxide	
High energy monopropellants	190–230
Nitromethane	
Low energy bipropellants	200–230
Perchloryl fluoride—available fuel	
Analine—acid	
JP-4—acid	
JP-4 and DMUH—acid	
JP-4 and organic unsaturate—acid	
Hydrogen peroxide—JP-4	
Medium energy bipropellants	230–260
Hydrazine–acid	
Ammonia–nitrogen tetroxide	
High energy bipropellants	250–270
Liquid oxygen—JP-4	
Liquid oxygen—alcohol	
Hydrazine—chlorine trifluoride	
Very high energy bipropellants	270–300
Liquid oxygen and fluorine—JP-4	
Liquid oxygen and ozone—JP-4	
Liquid oxygen—hydrazine	
Super high energy liquid propellants	300–385
Fluorine—hydrogen	
Fluorine—ammonia	
Ozone—hydrogen	
Fluorine—diborane	



One of the year's highlights was the successful static-firing of this 450,000-lb thrust Thiokol solid motor designed for Army's Nike-Zeus anti-missile missile.

State of the Art, 1958

Solid rockets

By Ivan E. Tuhy

THE MARTIN CO., BALTIMORE, MD.

CHAIRMAN, ARS SOLID ROCKET COMMITTEE

Ivan E. Tuhy is a member of the Rocket Propulsion Staff of the Flight Vehicle Dept. at Martin's Baltimore Div. With Martin since 1940, he was a structural designer on various military aircraft until 1947, when he began working on guided missile boosters and ordnance systems. He has contributed to the design or technical direction of all solid rockets used in the missiles developed by Martin. He was one of the organizers of the Maryland Section of ARS as well as a past president of the Section.

THE PAST YEAR has seen the military services, in almost every weapons category, change requirements in missile propulsion systems from liquid to solid propellant rockets, as evidenced by the Air Force's Minuteman, the Navy's Polaris and the Army's Pershing. Possibly, if more funds had been allocated a few years earlier for research and development in some of the liquid-solid competitive areas, this decision might have been made sooner.

Nevertheless, there have been significant breakthroughs in the state of the art of solid rocketry, in these areas among others:

Higher impulse and higher density propellants
High propellant mass fractions yielding minimum weight and size
Vector control and thrust termination

These advances made solids very attractive, especially in view of their commonly conceded advantages:

High reliability under varied environmental conditions
Minimum ground handling in preparation for launching
Instantaneous readiness
Minimum personnel for operations

The major developers and manufacturers of propellants and rockets in both the double-base and composite types indicate the availability of propellants approaching a specific impulse of 245 sec or higher. This has been no easy breakthrough, but has been achieved through the work of the propellant chemists, who, with their persistent and inventive attitudes, have tried hundreds of combinations that would meet the requirements of low temperature sensitivity, good physical and mechanical qualities, proper burning rates, high propellant densities, high flame temperature, low weight of combustion products, lack of resonant and unstable burning, and uncomplicated processing in manufacturing.

These are but a few of the requirements that must be met to make a propellant acceptable to the rocket designer. The high specifics in propellants will continue to go higher even within the next few years as various materials or chemicals are experimented with. These are out of the so-called C-H-O-N (carbon – hydrogen – oxygen – nitrogen) family.

However, along with this increase in propellant specific impulse, a problem of heat absorption must be faced, as the combustion flame temperature may soon exceed the limit our present throat materials can endure without some type of internal cooling.

During the past year, we have seen a big step forward in the ability of rocket motors to attain high propellant mass fractions, which two years ago seemed to be beyond the reach of the designer. With the advent of "cast-in-case" rockets, it was possible to reduce the weight of the normally thick and heavy liner considerably. The so-called "free standing" grain gave other problems which added to the rocket weight, i.e., suspension and trapping to prevent the grain from moving about during handling and then keeping the grain from jamming itself into the nozzle and causing the rocket case pressure to increase to a point where failure occurred. With the advent of cast-in-case propellants, most rockets do not require mechanical resonance suppressors and associated supports, which have been quite heavy.

Materials Being Improved

Indications from one of the material developers, namely, International Nickel Co., show that a new stainless steel which will be available soon will exhibit an ultimate tensile strength of 300,000 psi, corresponding to a strength-density ratio of 1.06 x 10^6. Titanium, on the other hand, does show promise as a new inert-parts material, but much more experience is required in the field of welding and forming. The poor high temperature characteristics of titanium where temperatures exceed 800 F may yield problems which may offset its advantages. A new series of low alloy steels containing vanadium in conjunction with chromium, nickle and molybdenum will possibly approach 300,000 psi ultimate.

Many rocket developers are conducting research and development on fiberglass filament winding. Nozzles and expansion cones, which previously have been overdesigned and made of steel of excessive thickness, are an ideal place for the use of fiberglass or asbestos reinforced resins, which have a density of less than one-fourth that of steel, and can remain essentially intact when exposed to temperatures of 5000 F for a period of 5 min.

These advances in inert- (CONTINUED ON PAGE 90)

Major advances in solid propellant technology show clearly in manufacturing and testing facilities for giant developmental motors. In order, top to bottom: A 300-gal (4000-lb) capacity Baker-Perkins propellant mixer at Thiokol's Utah Div., Brigham City; tilting bells at Aerojet's Sacramento Solid Rocket Plant, in which rocket cases are raised for propellant loading from overhead vats; Thiokol's 2 million-lb thrust static-firing bay at Utah Div., which will take a motor 12 ft in diam.; an early motor on the Polaris order being static-fired at Aerojet's Sacramento facilities; and a large single-nozzle motor developed by Aerojet in the preliminaries of the Polaris program.

Instrumentation and guidance

By Lawrence S. Brown

FORD INSTRUMENT CO., DIV. OF SPERRY RAND CORP., LONG ISLAND CITY, N.Y.

CHAIRMAN, ARS INSTRUMENTATION AND GUIDANCE COMMITTEE

Lawrence S. Brown, manager of Ford Instrument's Missile Development Div., has over 25 years of experience in instrumentation and guidance. A graduate of the 1932 class of the U. S. Naval Academy, he served in the Pacific Fleet with navigation and ordnance duties before joining Ford in 1934 as a field-test engineer on Naval fire control equipment. He was assigned to design engineering in 1940, work which brought him 12 patents on fire control, aircraft sights, bombing computers, and gyro and timing devices. In 1953 he went to Bulova R&D Labs as contract manager, and then as sales manager. He rejoined Ford in 1954 on the president's staff as project engineer for Redstone. In early 1956, he was assigned to his present position, with responsibility for guidance and control on Redstone and Jupiter.

IN THE FIELD of instrumentation and guidance, this has been a year which will be remembered not so much for scientific breakthroughs as for dramatic demonstrations of advances achieved through skillfully applied engineering. Although pushing of the state of the art proceeds apace, instrument engineers are somewhat aglow with the realization—which seems to come all too rarely—that giant steps have been taken. Tomorrow we must get back to the job, but today we can indulge in a little morale building by considering what has been accomplished.

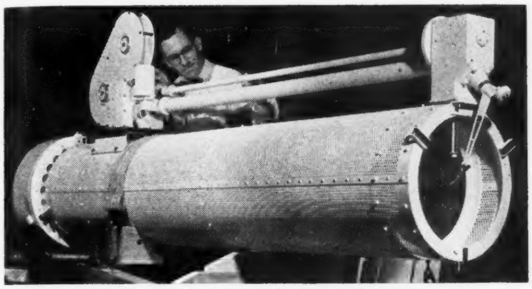
Guidance, control and instrumentation have played a mighty role in the results attained to date in our satellite program. Controlling into orbit, sensing and measuring, transmitting—all are the results of imaginative yet careful engineering, and have made possible our first useful exploration of space. The most dramatic find has been the intense cosmic radiation reported by the Explorers. Further information as to the depth, gradient and type of this radiation is vital to the problem of manned space travel.

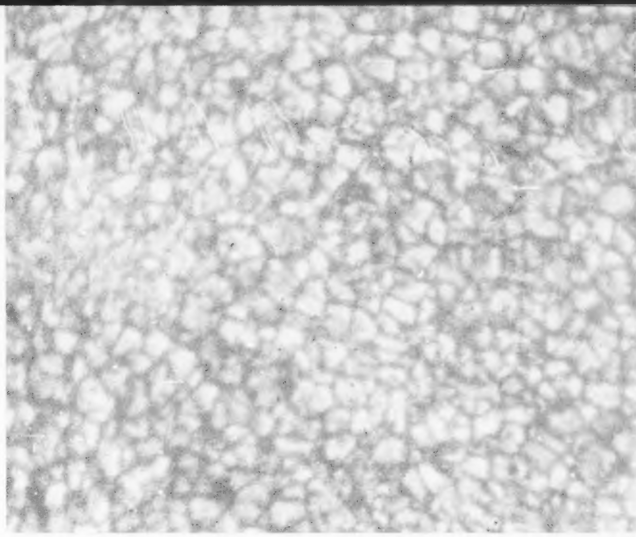
Successful Guidance Already Demonstrated

The "quod erat demonstrandum" of long-range ballistic missile guidance—among other things—was quite forcefully proven by the recovery of Jupiter IRBM full-scale nose cones on May 18 and July 17 of this year. The extent of the test's success is indicated by the perfect functioning of nose cone instruments during re-entry and even after recovery. Demonstration of the pickle-barrel accuracy of the inertial guidance system of the missile was evidenced by the amazingly short time required for recovery—only 90 min after liftoff.

The remarkable aquanautic feat of our Navy's nuclear submarines in their polar transits was a milestone in guidance technology, albeit in very wet inner space. The combination of inertial and other advanced navigation instruments made these trips possible. There are striking parallels between such an operation and manned travel into outer space. Perhaps the most likely candidates for manning the Venus Express can be found in the crew of Nautilus and Skate. In any case, the instruments involved will be of similar importance.

Encouraging advances have been made in the planning and development of weapon systems that are functionally integrated, rather than a hurried hodgepodge of available subsystems. This approach can lead the way to the ultimate in miniaturization and reliability, ingredients which are a must for adequate weaponry and space vehicle control. Interesting work is underway for apply-





Aimed at the sun by a photo-electric servo system, and employing a secondary mirror of quartz which rotates once per sec to prevent overheating, this Perkin-Elmer telescope, carried to 80,000 ft by balloon, took the accompanying picture of the sun's surface, showing turbulent areas 300–500 miles apart. This is the kind of instrument with a future in space exploration.

ing such integration to electronic devices in a fashion that may in time obsolete the single-function component. This involves molecular circuitry, or the performance of multiple circuit functions by control of electron motion within a vacuum or a solid.

Includes Ground Support Equipment

The systems-integration discipline has in the recent past been more generally applied to include missile ground-support equipment requirements. Lack of such attention to this very important weapon system area had been part of the growing pains of earlier missile programs. Increased automation of ground equipment is making more practicable the utilization of complex systems.

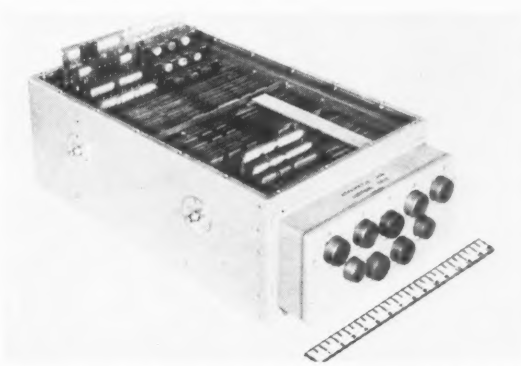
In the battle for space (and weight) between instruments and fuel, the trend to use of semiconductors is snowballing. This is being aided by increased attention by transistor manufacturers to the vital need for increasing reliability by better process control, sealing and testing methods.

Radar will be with us for a long time on earth (and presumably off it) and development proceeds encouragingly along several fronts. The application of ferrites to the microwave field is assuming considerable importance. Progress on solid state maser amplifiers appears to have passed the laboratory stage on its way to application in equipment for field tests.

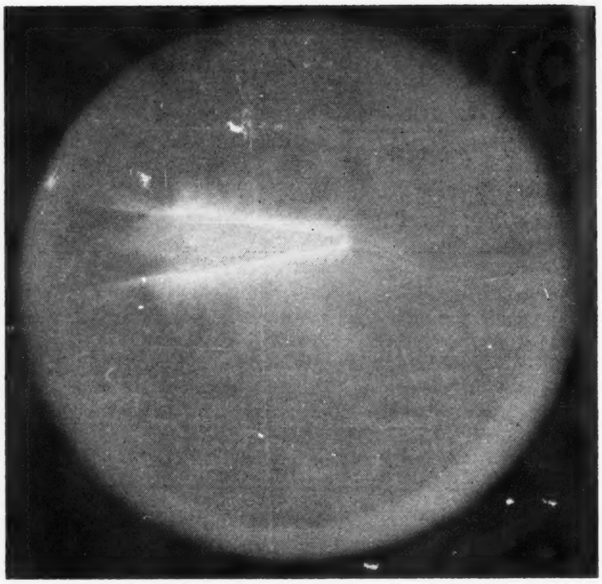
Advances in the optical-instrument field can be typified by the successful photographing of the granulation of the solar surface with extreme resolution. These photos were made by a solar telescope of 96-in. focal length and 12-in. aperture while suspended from Skyhook balloons at 80,000 ft. The telescope was pointed at the sun by a photo-electric servo system. This is the sort of instrument with a likely future in space. Another instrument being developed for missile tracking (to obviate the laborious task of film reading and data reduction) uses photocells and sensitized grids which can give data in digital form for immediate on-site reduction.

Some of the instrument requirements of the near future for missilery and space travel will certainly be met by logical extensions of present techniques and developments. However, many of them, as in the propulsion and human factors field, will demand drastically new thinking and creative effort.

An example of the latter relates to the application of inertial navigation to interplanetary travel. Contrasted with ICBM parameters, operating times will be many orders of magnitude higher and accelerating forces will be several orders of magnitude lower. Measurement of the latter is essential to an inertial system. The (CONTINUED ON PAGE 136)



Shown for the first time this fall, this completely transistorized computer, Philco's digital Transac C-1100, handles all computations necessary to control and navigate a jet plane.



Glowing solid propellant cone with incipient flame on its surface ignited by shock tube blast in ignition study.

State of the Art, 1958

Propellants and combustion

By John L. Sloop

NASA LEWIS RESEARCH CENTER, CLEVELAND, OHIO
CHAIRMAN, ARS PROPELLANTS AND COMBUSTION COMMITTEE

John L. Sloop is head of the Rocket Branch of NASA's Lewis Research Center (formerly the NACA Lewis Flight Propulsion Laboratory), a post he has held for almost 10 years. After receiving his B.S. in electrical engineering from the University of Michigan in 1939, he joined the Lewis staff in 1941, heading a group studying spark ignition for four years and later heading up research on rocket cooling for two years. In 1949, he became head of the Lewis Rocket Research Section and that same year was moved up to his present position. A fellow member of ARS, he succeeded John Tormey of Astrodyne as chairman of the Propellants and Combustion Committee earlier this year.

THE HIGHLIGHT of the past year for propellants and combustion was, as for other areas of rocketry, the successful launching of the several earth satellites. Even though the satellites used propellants or combustion processes that are not new, they mark a great milestone in man's successful use of chemical energy for propulsion. North American Aviation, the Jet Propulsion Laboratory of California Institute of Technology, General Electric, Aerojet-General, Grand Central Rocket, Allegany, and Thiokol played important roles in this propulsion accomplishment.

Progress in propellants and combustion is seldom marked by spectacular discoveries or "breakthroughs," but rather by the steady accumulation of knowledge by a great number of scientists and engineers. A scientist specializing in combustion, for example, will readily admit that the chemical processes in simple diffusion flames still hold many mysteries, despite years of study. Nevertheless, the effort in combustion is evidenced by the large number of excellent contributions to the literature and the growing number of people who participate in the Combustion Symposia held every two years under the auspices of the Combustion Institute and in the AGARD meetings.

Seven "Useful Half-Truths" of Combustion

To single out a few of the contributions in the combustion field is to risk leaving out others equally important. Nevertheless, D. B. Spaulding of Imperial College, London, England should be mentioned for his thought-provoking AGARD paper on the seven "useful half-truths" of combustion, which he describes as ". . . sufficiently compact to be memorable, sufficiently general to cover most situations and sufficiently near the truth to form useful approximations to reality."

Another contribution is the work of Melvin Gerstein and his associates, A. E. Potter and F. E. Belles, on calculation of quenching

distances of flames, prediction of detonation limits of hydrogen and oxygen from the kinetics of reaction and strength of the shock wave, and a review of chemical processes in flames.

Lester Lees presented an excellent paper on convective heat transfer with mass addition and chemical reactions. S. S. Penner has continued to make noteworthy contributions on combustor scaling and spray combustion. Robert Gross deserves mention for his work in magnetohydrodynamics and, with A. K. Oppenheim, for their work on detonation. And there are many others.

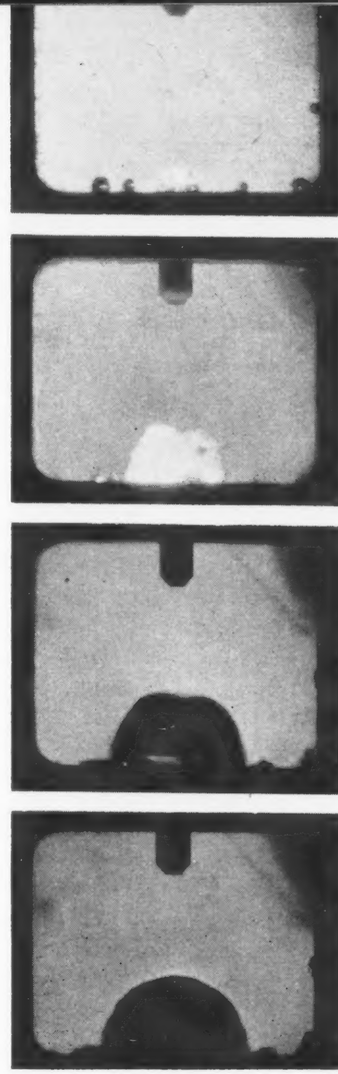
A large accomplishment this year has been the continued perfection of the shock tube as a tool in studying reaction kinetics at high temperatures. The kineticist sorely needs better techniques to understand the behavior of chemical species in rapid reactions in heterogeneous burners.

Progress Made on Propellants

So much for combustion. What about propellants? Unfortunately, the gentlemen who toil in this field and their accomplishments are more obscure than their counterparts in combustion because they walk a narrow line between proprietary and security. Recently North American–Rocketdyne prepared a fuel blend they dubbed Hydyne which easily adjusted to an existing missile system and improved its performance. It was their second step in using propellant studies to improve the performance of their large engines. The first step, you may recall, was a switch from alcohol to kerosene.

And, although it occurred several years ago, I still want to shake the hand of the resourceful Aerojet-General experimenter, Scott Kilner, who had trouble with his flowmeter calibrations and found a long-standing error in the density of liquid fluorine. Some handbooks still haven't gotten the word.

The work of Battelle Memorial Institute in compiling data on liquid propellants has filled a great need and is the most valuable single reference in the field. (CONTINUED ON PAGE 143)



Ignition of liquid hydrazine by submerged electrical discharge. Successive frames show explosion at $^1/_{50}$th-of-a-second intervals.

Schlieren photo of propane-air flame stabilized on heated flat plate in high speed flow as part of study of low-drag flameholders for high output combustors.

Human factors

By David G. Simons, Lt. Col., USAF(MC)

USAF MISSILE DEVELOPMENT CENTER, HOLLOMAN AFB, N. MEX.

CHAIRMAN, ARS HUMAN FACTORS COMMITTEE

David G. Simons is now Chief of the Holloman AFB Aero Medical Field Laboratory, which conducts the AF program on the biological hazards of radiation at high altitudes. Graduated with an MD degree from Jefferson Medical College in 1946, he joined, after his internship, the Aero Medical Laboratory at Wright Field, where he served as project officer for rocket experiments on the physiological response of monkeys to weightlessness. In 1949–50 he attended the school of advanced courses in aviation medicine at the School of Aviation Medicine, Randolph AF Base, Tex., and then was assigned for 2½ years to the Korean theatre. On his return from Korea, he was assigned to Holloman, later becoming Chief of the Space Biology Branch of the Aero Medical Field Lab and gaining recognition for his contributions in the fields of animal experiments with sounding rockets and the Manhigh project. Col. Simons was the pilot of the record breaking 32-hr Manhigh II flight, which took him to an altitude of more than 100,000 feet.

TO MANY ARS enthusiasts who have thought in terms of space flight for years, our entry into the space age during 1958 seemed dishearteningly slow. Taking a broad perspective, however, we find impressive the orientation of national thinking toward space and the reorganization of the research and development effort in the light of this new perspective. Indeed, in terms of specific accomplishments, 1958 has been a fertile year.

The year began with announcement of a major step toward protecting man in space ventures—an aluminized pressure suit developed by David Clark and Scott Crossfield under the direction of WADC. This suit represented major advances in pilot maneuverability and protection from the vacuum of space and extremes of heat and cold.

The week spent by Airman Farrel in the School of Aviation Medicine's space chamber introduced the public to a more concrete notion of man in space. During this simulated flight, pressure in the cabin was reduced to half an atmosphere. Information from the test underscored the need for more research on sealed-cabin atmospheres. Many programs are now in progress in this area, some immediately directed to submarine design.

The test also pointed to the acute problem of how to simulate realistically the complex of conditions that will be encountered in actual space flight, for it did not permit detailed analysis of Farrel's psychological reaction to confinement. The cabin, moreover, did not provide the weightlessness or emotional tension that a man in a satellite would feel.

A similar study was conducted at WADC with five men in a small cabin for five days. This test, conducted with a normal atmosphere, concentrated on the social reaction of the group.

A number of space-simulating cabin runs were also made in preparation for Manhigh III. In these runs, an experimenter stayed in a cabin at half an atmosphere for 24 hr, and the interactions of his psychology and physiology were studied. A battery of tests was established to select the pilot for Manhigh III, as part of a project directed at finding the answers to the question of "What tests should be used to select a space pilot?"

Later in the year, a successful Navy Strato-Lab flight by Malcolm Ross and Lee Lewis demonstrated the effectiveness of balloon-borne research laboratories.

A major milestone toward space flight was reached at WADC when a man tolerated 14 g's applied transversely to him in a semi-

supine position, with the torso flexed between 25 and 30 deg and the knees bent nearly 90 deg, as he would be in a cramped capsule. Later, a man riding the Johnsville centrifuge in a molded full-body support withstood 21 g's applied transversely without suffering any lasting adverse effects. These tests showed the possibility of developing a means of protecting space pilots from re-entry accelerations greater than 10 g's.

A record for man's tolerance to abrupt deceleration (in a controlled test) was established in May when Capt. Eli Beeding withstood a peak of 83 g's on the Holloman Daisy track. Experiments with chimpanzees indicate that the limit of human tolerance to acceleration may be much greater than even this figure for short periods of time.

Of major import for space flight was the completion of the simulated X-15 flight profiles on the Navy centrifuge at Johnsville. These runs have been invaluable both to pilots and engineers because they provide dynamic simulation of aircraft performance with the control console that will be used in the aircraft. An unhappy event in the space flight program was the untimely death of Capt. Iven Kincheloe, one of the pilots scheduled for X-15 flights, in a routine test of a jet aircraft.

Have Learned of New Radiation Belt

From the satellites, we have learned of a hitherto unknown radiation belt, which, regardless of its exact composition and extent, will exert a profound influence on the structure of manned space craft and the selection of flight patterns.

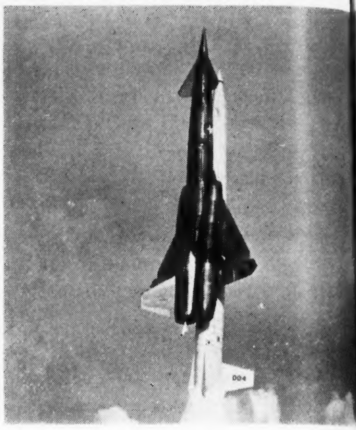
Several noteworthy meetings were held during the year in addition to the regular professional ones. A symposium on the biological aspects of satellite flight was held in Washington under the joint sponsorship of the National Institute of Biological Sciences, the National Academy of Science and ARDC. This meeting provided a much-needed opportunity for biologists to learn more of the nature and scope of the problems associated (CONTINUED ON PAGE 77)

Left, the week-long stay of Airman Donald Farrel in a 3 x 5-ft cabin dramatized the approaching reality of man in space.

Right, balloon flights like this Manhigh II one are also helping to pave the way for man in space.

State of the Art, 1958

Ramjets



By Brooks T. Morris

MARQUARDT AIRCRAFT CO., VAN NUYS, CALIF.
CHAIRMAN, ARS RAMJET COMMITTEE

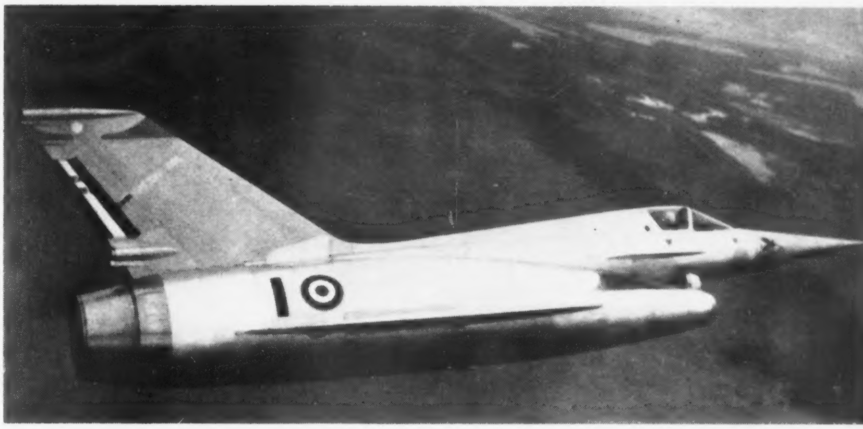
Brooks T. Morris is Executive Engineer of the Powerplants Engineering Division of Marquardt Aircraft Co. An old-time fluid mechanics laboratory man educated at Stanford University, he entered the rocket and jet propulsion field at Aerojet in 1943. He has been a member of the AMERICAN ROCKET SOCIETY since 1948 and with George Sutton was a co-founder of the Southern California Section. In addition to his recent work in the supervision of ramjet engine development, he is remembered for pioneer work in liquid rockets and pulsejet engines. He has been chairman of the ARS Ramjet Committee for the past two years.

IN THE three years since William H. Avery's comprehensive summary, "Twenty-Five Years of Ramjet Development" (JET PROPULSION, November, 1955), much of the application which he forecast for the "youngest of the family of jet propulsion devices" has come to pass. At that time he listed "a few of the applications in which the ramjet is a preeminent choice." These included anti-aircraft guided missiles, target drones, long-range bombardment aircraft and nuclear-powered ramjets.

Since then, hundreds of missile and test-vehicle flights have proved over and over again the suitability and reliability of ramjets for such applications. Each of the U.S. military services and several of the NATO countries have sponsored such activity. Moreover, there is evidence of a high degree of technical sophistication in Russian ramjet art.

The 1955 appraisal by Dr. Avery of ramjet speeds and altitudes estimated an upper speed limit of Mach 4. Since then, at least one flight above Mach 4 has been reported, and advanced studies now indicate future ramjet capability at and beyond Mach 7. A summary of known and estimated ramjet propulsion speed trends is indicated in the chart on page 61. The semi-log plot of Mach number versus time in years is typical of missile and aircraft projections.

The major application of ramjet propulsion is currently in the field of anti-aircraft guided missiles. The names Bloodhound, Bomarc and Talos are familiar throughout the western world as identifying ramjet-propelled weapons. Each of these missiles employs a first-stage rocket booster and a ramjet second-stage sustainer. The Bristol Bloodhound and the Boeing Bomarc each have two strut-mounted nacelle-type supersonic ramjet engines, developed and manufactured as the Thor (British) and the Marquardt (U.S.) RJ43. The Talos (U.S.) incorporates an integral ramjet developed under the technical leadership of the Applied Physics Laboratory, Johns Hopkins University, and with the cooperation of a large group of industrial contractors. Each of these ramjet propulsion systems incorporates fixed-geometry engines and automatic thrust and speed control involving novel mechanical equipment. To the everlasting credit of the men responsible for these programs, a high standard of weapon flight reliability has resulted from their design, development, manufacturing and testing activities.



Ramjet development in pictures. Left to right, North American's Navaho, which explored the possibilities of air-breathing engines for large missiles; Lockheed's Kingfisher, a supersonic ramjet drone; and the French Griffon II, capable of high supersonic speeds under ramjet propulsion from a mixed powerplant.

In general, today's anti-aircraft ramjets adhere closely to the state of the art as foreseen by Dr. Avery, and exploit a large fraction of the flight envelope he forecasts. Such ramjets have operated at thrust-weight ratios as high as 20 to 1. The leading position of U.S. ramjet engines and missiles of this class is attributable to the large ground-testing laboratories of NASA's Lewis Research Center, AEDC's Engine Test Facility, and other such plant-located facilities as those at Marquardt and Curtiss-Wright. Through very substantial and ingenious efforts, testing capacity comparable to much of the anti-aircraft or interceptor flight envelope has been provided in these facilities.

Successful Kingfisher Firing

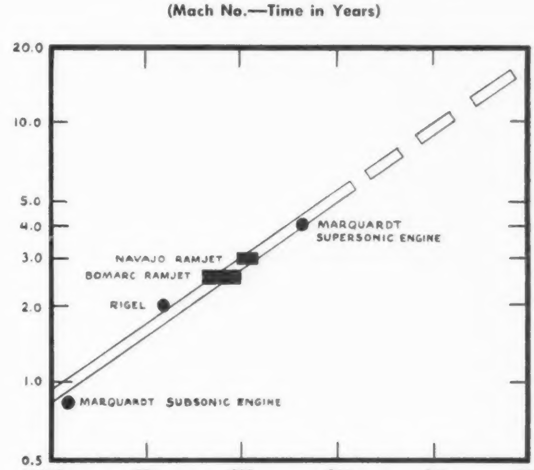
News stories of Aug. 12, 1958 report the successful demonstration of a Talos missile fired against a ramjet propelled target aircraft, the Lockheed Kingfisher, by the U.S. Army at White Sands. Shown above, Kingfisher is a very high performance recoverable supersonic target aircraft derived from the X-7 ramjet test vehicle series developed and operated for the Air Force by the Lockheed Missile Systems Division. The X-7 vehicle has been a major tool in the development and flight evaluation of the ramjet engines used for Kingfisher propulsion.

Although the preponderance of technical opinion seems to favor ramjets as an economical, efficient means of supersonic drone propulsion, the uncertainties in target planning concepts have tended to delay their adoption until only recently.

The third of Dr. Avery's categories, long-range bombardment aircraft, is represented by the U.S. Air Force Navaho missile program. Curtiss-Wright ramjet engines of outstanding size, speed and power rating are used in this North American Aviation missile. In spite of the much publicized cancellation of the Navaho program, test vehicles flown since have shown highly creditable ramjet performance. Evidence of the potential of the ramjet powerplant is available from many applications. The Air Force, for example, wanted a long-range intercontinental missile capable of supersonic flight. Designated the "Navaho," this missile was to be powered by Wright Aeronautical ramjet engines and was to fly faster even than our most advanced bomber in the planning stage. The ramjet engines for this application passed development and preflight rating tests, and have since flown with demonstrated 100 per cent reliability in all flight tests. In every Navaho flight when the vehicle was boosted to the proper ramjet starting conditions, satisfactory ramjet ignition and performance was achieved. This vehicle can fly 18 mi high; and its payload limit was many times greater than today's ICBM with no increase in gross takeoff weight. (CONTINUED ON PAGE 140)

Ramjet Propulsion Speed Trends

(Mach No.—Time in Years)



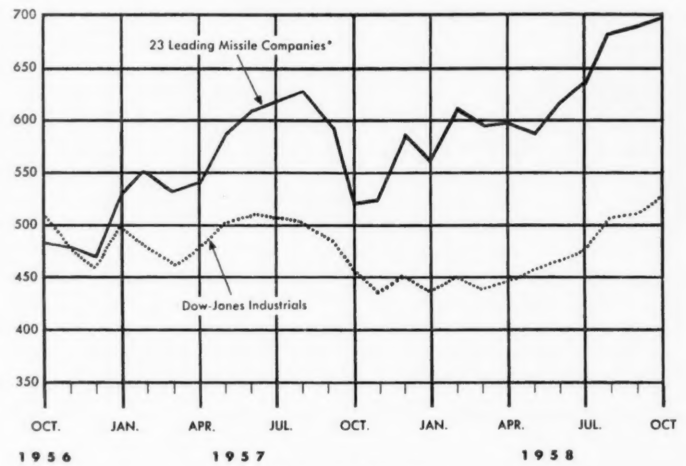
Missile market

ROBERT H. KENMORE, *Financial Editor*

This month's guest columnist is Jerome M. Pustilnik, ARS Member, security analyst and member of the Research Dept. of the New York Stock Exchange firm of Eisele & King, Libaire Stout & Co.

BY JEROME M. PUSTILNIK
Eisele & King, Libaire Stout & Co.

THE MARKET AT A GLANCE



*Index compiled June, 1955

	Oct. 1958	Sept. 1958	% Change	Oct. 1957	% Change
Dow-Jones Industrials	527	508	+3.7	457	+15.3
Missile Index	694	683	+1.6	518	+35.8

ANY INDUSTRY that can grow by 20,000 per cent in seven brief years is bound to attract the attention of investors and security analysts. When glamor is the handmaiden to this startling growth, stock market fireworks, with explosive rises and declines, are put on display. These pyrotechnics have often illuminated the securities of companies comprising the missile industry. But the "rockets' red glare" should not blind investors to the actual long-range nature of this industry's growth, nor should the industry's vogue and fashion—even unsophisticated investors speak easily of boost-glide skip bombers, ion propulsion, space vehicles and lunar probes—veil its true growth potential from our eyes.

Although the last two years have seen a steady advance in the missile index, and dollar expenditures for missiles have leaped from $21 million in 1951 to the $5 billion appropriated for fiscal 1959, this is just the start. By 1975, informed sources estimate the Pentagon will be spending between $35 and $45 billion per year on missiles, with over $5 billion per year going for research and development alone. Pronounced future growth, and not merely glamor, is thus the fundamental investment characteristic of the industry.

Why will it be necessary to spend such huge sums? What are these dollar estimates based upon? Few investors, even those employed within the industry, realize the almost staggering scope of missile work and the current primitive state of the art. Few investors are aware that the current generation of missiles—Jupiter, Thor, Atlas, Titan—represent the Model T's of the missile age, even though they are marvelously intricate vehicles. These first-generation weapons will be replaced by improved, more sophisticated, models with billions spent on their development. And no end to this cycle of obsolescence and replacement is in sight as long as the cold war with Russia continues.

But the birds themselves are only the beginning. There is a continuing demand for goods and services. The missile and all its components must be continually checked and tested; test equipment must be manufactured; and training devices must be produced to teach ground crews their jobs. Huge amounts of electronic equipment are also necessary to fire, guide, track, detect, warn, etc. A fool-proof communications systems, capable of handling a vast flow of information in a very short time, is also needed. There are also programs for anti-missiles, anti-anti-missiles and for electronic countermeasures.

What specific area of the missile industry currently merits investment attention? One of the most attractive, we feel, is missile electronics, which receives one of the largest portions of the missile dollar. And, within this field, infrared appears especially interesting. Infrared, which cannot be jammed, is beginning to seriously challenge radar's monopoly, and is being used in guidance systems to track and to detect missiles, aircraft and submarines. It is also used for reconnaisance from earth satellites. In industry, IR measures the composition of fluids in the complex processes of the chemical, petroleum refining and distilling industries. IR cameras also analyze metallurgical and material processing operations, aiding accuracy and quality control.

Many companies are turning out infrared instruments, including the giants of the electronics field, although it represents a very minor fraction of their business. There are, however, two relatively small companies that specialize in infrared, and appear to be very promising. These are *Perkin-Elmer Corp.* and *Barnes Engineering Co.*, both of Norwalk, Conn., and both traded over-the-counter.

Perkin-Elmer today occupies a leading position in infrared. With the company continuing to emphasize its research program, growth prospects are impressive. Founded in 1937 as a small manufacturer of precision astronomical optics, the company's growth was stimulated by optical systems it devised and produced during WW II, including work on the Norden bombsight. Later, the company did pioneer development work on the IR spectrometer, now considered the best way to analyze complex chemical compounds. New analytical instrument fields have been developed, including continuous process control. The com-

(CONTINUED ON PAGE 120)

International scene

BY ANDREW G. HALEY

TWO MAJOR items of unfinished business from this year's IAF Congress and previous meetings remain on the agenda for the 10th Congress next year, to be held in London Sept. 13–20.

The first of these is consideration of the report by the Committee on IAF-ICSU (International Council of Scientific Unions) cooperation, chaired by Theodore von Kármán. In its report, the Committee urged formation of three IAF Divisions, in the fields of the space sciences, space technology and social sciences relating to space problems. The Division of Space Sciences will be concerned with the broad spectrum of physical, mathematical, astrophysical and life sciences related to space and, the Committee believes, will be qualified as a participating group in the recently formed ICSU Committee on Space Research (see page 118).

Final action on this proposal is expected to be taken at the London meeting. Obviously, some sort of IAF reorganization is imperative to qualify it for membership in such organizations as ICSU.

Another proposal deserving of careful consideration is that by Eugen Sänger, head of the German Gesellschaft für Raketentechnik und Raumfahrt, originally made at the Rome Conference in 1956, to establish an Academy of Astronautics. Action at this year's meeting in Amsterdam was postponed at the suggestion of Dr. Sänger on the grounds that insufficient time was available to discuss the matter in detail at the concluding plenary session.

° ° °

The alert attitude of the U.S. Congress toward the legal problems of outer space was clearly demonstrated at the IAF Space Law Colloquium at The Hague during the Amsterdam meeting. Significantly, the paper prepared by Rep. Kenneth B. Keating (R., N. Y.), the ranking member of both the Judiciary and Space Committees of the House, was similar in its recommendations to the legal resolution adopted by the Federation itself.

Rep. Keating, who for some time has been in the van of those urging a beginning Space Code, pointed out that an initial study of the possible areas of legal agreement should be started at once—preferably by some experienced science-law group outside of, but in relation with, the UN. He suggested that the IAF itself serve as the vehicle for this study and that its work form the basis for a subsequent world conference on the use of outer space, to be held as soon as possible after completion of the study, possibly within a year or two of the present time.

Interestingly enough, within a week of The Hague colloquium, Henry Cabot Lodge, U.S. Ambassador to the UN, had proposed an ad hoc committee to look into general areas of world cooperation in the development of outer space. Whether this is intended to include legal problems, however, has not yet been made clear.

° ° °

Both the House and Senate Space Committees sent observers to the Amsterdam Congress. Representing the House Committee was its assistant staff director, Charles S. Sheldon. Dr. Sheldon, a former professor of economics at the Univ. of Washington, is considered one of America's top transportation authorities. Representing the Senate Committee was Mrs. Eilene Galloway, research analyst for the Library of Congress, and special consultant to the committee.

° ° °

Three members of Congress were originally scheduled to give papers at the Space Law Colloquium. Sen. Alexander Wiley (R., Wis.) a member of the Senate Space Committee, was unable to attend. Also, at the last moment Rep. Keating, who had just been nominated for the Senate at the New York GOP convention, had to cancel his plans to attend. His paper, however, was read by Dr. Sheldon.

One important member, Rep. James G. Fulton (R., Pa.) was able to be present, and delivered a major address at the colloquium. Rep. Fulton, who has an unusual background in mathematics, science and law, and is a ranking member of the House Foreign Affairs Committee, as well as the Space Committee, skillfully demonstrated the need for legal principles in the space arena by tracing the philosophical background of science and national power throughout history.

George J. Feldman, director and chief counsel for the House Space Committee also attended the Hague meeting, after spending a number of weeks in other Western European countries conferring with prominent scientists in the astronautics field. A former law professor as well as a practicing attorney, he was one of the principal architects of the new National Aeronautics and Space Act. His statement before the colloquium was particularly enlightening to lawyers from other countries, since it presented, at first hand, the provisions of this pioneer statute, plus the thinking and reasoning which lie behind U.S. space law efforts.

Philip B. Yeager, staff consultant to the House Space Committee, also attended the colloquium. A journalist and editor by profession, a lawyer by avocation, and one-time professor of public administration at Tufts College, he has been active in space law research since 1953. His paper provided a marked change of pace from the doctrinaire approach, probing into the sociological developments of past and current civilizations, and superimposing the need for a beginning space code upon geopolitical trends of the future. His concept of moral-intellectual leadership as a major political instrument of tomorrow's international world carried the hallmark of fundamental thinking.

The carefully conceived ideas of Mrs. Galloway on the "community of law and science" provided another major contribution. Mrs. Galloway emphasized the growing interrelation between the two and warned of the disasters which are likely to arise if both professions insist on going their separate ways.

Japan's Kappa II Rocket Rises More Than 30 Miles

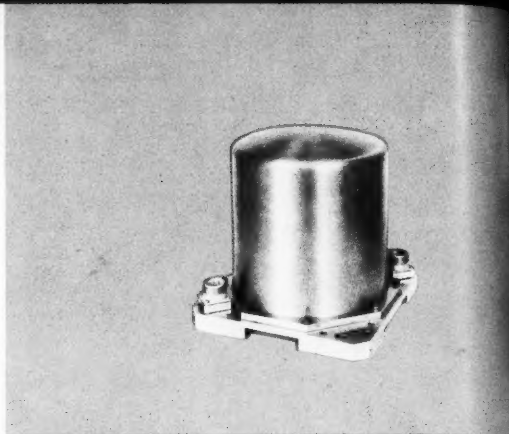
TOKYO—Still smarting from the earlier failure of Kappa I, Japanese scientists participating in the IGY program were jubilant when a two-stage Kappa recently reached an estimated altitude of 32 miles. The 550-lb, 18-ft rocket, employed to observe temperatures and wind velocity in the upper atmosphere, was launched by a rocket team of Tokyo U.'s Research Institute under Hideo Itokawa. Dr. Itokawa reported that a sonic bomb used in making readings exploded 80 sec after the rocket fired, and radar was able to record data for about 29 sec.

Following the lead of other IGY nations, the Japan Council of Science has announced that it too will participate in a program planned to follow up the 1957–58 IGY observations ending Dec. 31. —R.L.

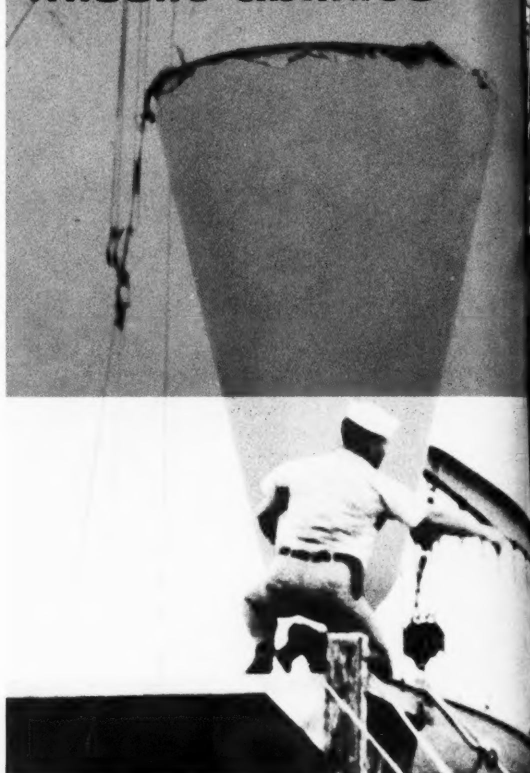

FORD INSTRUMENT CO.
DIVISION OF SPERRY RAND CORPORATION
Long Island City 1, New York
MISSILE SYSTEM CAPABILITIES

More than four decades of military systems engineering insure operational equipment... whether systems, subsystems or components

FORD INSTRUMENT



missile abilities



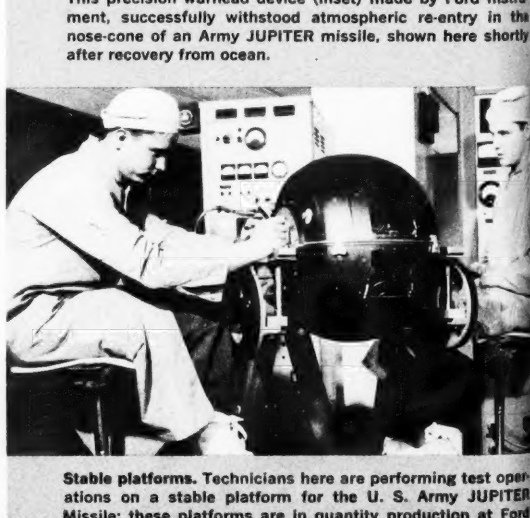
Warhead devices for missiles and other modern weapons. This precision warhead device (inset) made by Ford Instrument, successfully withstood atmospheric re-entry in the nose-cone of an Army JUPITER missile, shown here shortly after recovery from ocean.

A unique combination of electronic, electrical and mechanical skills, devoted since 1915 almost exclusively to furtherance of military science, is the basic strength of Ford Instrument Co. Almost all of Ford Instrument's existence has been devoted to research, development and production of highly complex equipment, with laboratory precision and accuracy, yet able to withstand the rigors of military environments.

The proven reliability and extreme accuracy of the REDSTONE and JUPITER missiles, which employ guidance and control systems built by Ford Instrument—as well as the record of the JUPITER C—indicate clearly the company's capabilities in the area of guidance and control.

Another recent example of this type of work is Ford Instrument's design and manufacture of intricate warhead safety, fuzing and arming devices capable of withstanding the roughest environments. Few manufacturers are willing or able to undertake projects such as this and to carry them to completion. Ford Instrument has earned the reputation—which we are proud to acknowledge—of being able to do the "toughest jobs" in missile development and manufacture.

Contracting agencies or industries, with requisite security clearance and "need to know," are invited to examine further Ford Instrument abilities in difficult phases of missile research, development and production ... whether for complete systems or specialized subsystems and components.

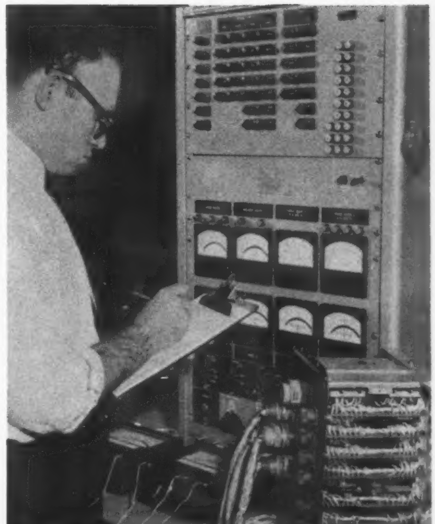


Stable platforms. Technicians here are performing test operations on a stable platform for the U. S. Army JUPITER Missile; these platforms are in quantity production at Ford Instrument.

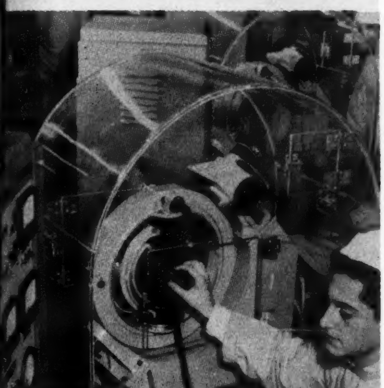
Launching and control order computers for TARTAR Missiles. Electronic and electromechanical portions of this all-transistorized modular computer are shown at left and right.

Actuators for jet vanes, air control-surfaces. This rotary actuator is driven by 1 hp d-c servo motor (shown in foreground with cable attached). Both motor and actuator are made by Ford Instrument.

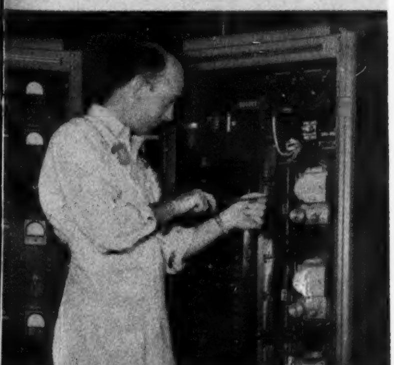
Missile-borne inverter. Vital missile component gets rigorous, precision performance checkout at console. All of the missile products delivered by Ford Instrument undergo full and complete testing procedures.



Missile-borne computers. Ford Instrument computer experience covers every phase of ballistic missile guidance and control. Typical is this control computer, shown during test, for U. S. Army JUPITER.



Specialized gyros and accelerometers. Ford Instrument pioneered in the quantity production of air-bearing gyroscopes and accelerometers. Air-bearing gyro here undergoes final test in special Ford-built test equipment.



Ground support equipment. Here pre-launch computer undergoes final adjustment. Modular techniques enabled this unit to be produced and delivered in less than 6 months.

current missile projects and equipment

SYSTEMS
- Inertial guidance and control systems and related ground support equipment
- No-gimbal pure integration inertial system
- Launching and control order computers
- Command guidance systems (for both missile and drone applications)
- Trajectory data system
- Missile velocity indicating system for test range applications
- Target locating system
- Radar target prediction and interpretation systems

SUBSYSTEMS (Missile-Borne)
- Safety, fuzing and arming devices
- Stable platforms
- Computers (control computers, guidance computers)
- Programming devices
- Inverter-regulators
- Transmitters

GROUND SUPPORT EQUIPMENT

Maintenance area, launch site and monitoring equipment, including:
- Impact prediction computer
- Aiming correction computer
- Pre-launch computers
- Test panels for computers and stable platforms
- Shipboard dynamic testers
- Monitor panels for guidance, stable platforms, alignment, and laying
- Test fixtures for a wide variety of components
- Combined sensor displays

PRODUCTION TEST EQUIPMENT

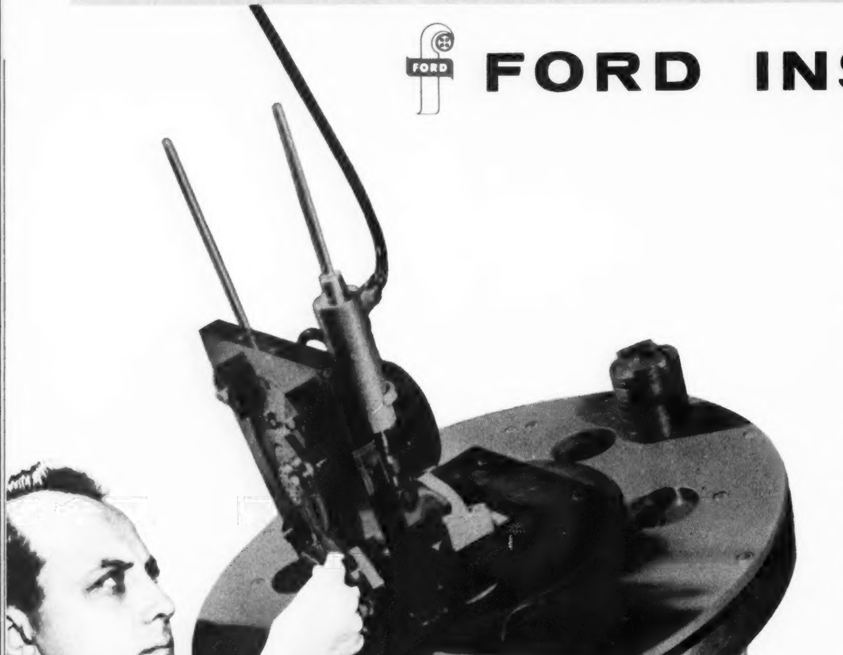
Systems and component test equipment including:
- Special environmental test units
- Quantity production test units
- Planetary test stands

SPECIALIZED COMPONENTS
- Gyroscopes
- Accelerometers
- Actuators
- Mechanical integrators
- Transistorized amplifiers
- Relay packages
- Computer modules, both analog and digital, for a variety of missile problems
- Timing devices
- Shipping and storage containers

Drafting. One of Ford Instrument's many drafting departments, where topflight design draftsmen and technicians support research and development and also produce production drawings.

Technicians perform final checks on stable platforms for U. S. Army REDSTONE Missile in ultra-clean assembly area.

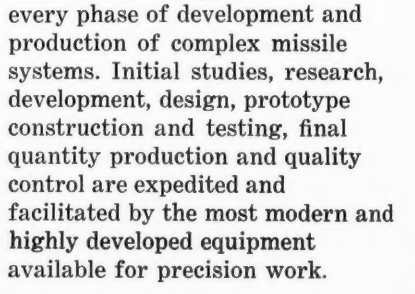
FORD INSTRUMENT



Extensive production and laboratory equipment implement engineering skill

Ford Instrument physical facilities make it one of the largest high-precision shops in the United States, fully equipped to handle every phase of development and production of complex missile systems. Initial studies, research, development, design, prototype construction and testing, final quantity production and quality control are expedited and facilitated by the most modern and highly developed equipment available for precision work.

Contracting agencies and industries possessing requisite security clearance are invited to make an on-the-spot inspection of Ford Instrument facilities.

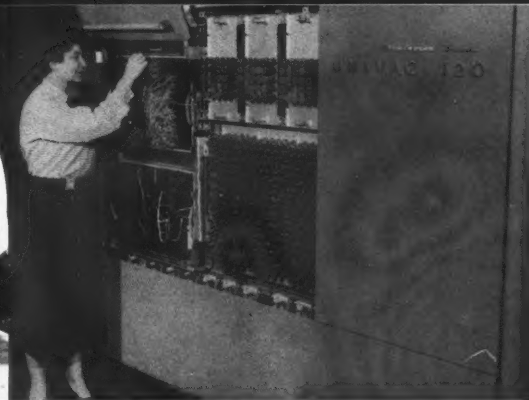


Equatorial test stand, built by Ford Instrument for its own laboratory facilities, is used for conducting basic drift error research. This type of unit can

Many hundred standard machine tools, a few of which are shown here, are available at Ford Instrument for missile applications, as well as a wide

Missile-borne tape programmers being assembled. Continuous development in this field is under way at Ford.

Air-bearing gyro accelerometer is tested here in Ford designed and built special fixture.

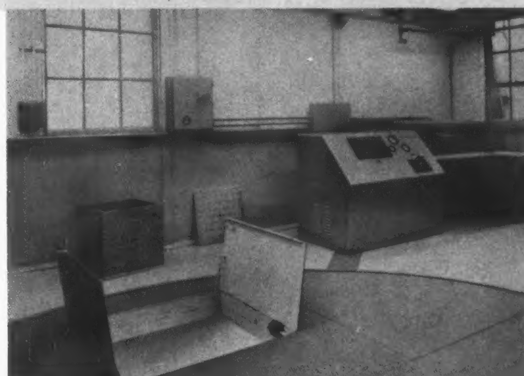


"Univac" computer is one of the general-purpose high-speed digital computers at Ford Instrument for engineering computations.

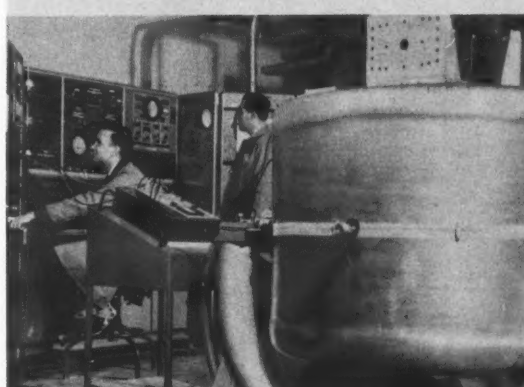
missile facilities

Typical of Ford Instrument Facilities:

- More than 30 laboratories for research, development and design in electronics, hydraulics, magnetics, mechanics and nucleonics, including fully equipped, ultra-clean gyro facilities.
- Advanced digital computing facilities with high-speed general purpose computers, including a Remington Rand "Univac." Ford Instrument scientists also have access to computing facilities of the Remington Rand Univac Division.
- An engineering shop, as large as many small manufacturing concerns, staffed by expert machinists and technicians, working under direct engineering supervision. The company also has fully staffed and equipped "short run" and prototype shops.
- Full production facilities—machine tools, shops, finishing and inspection facilities—for *large-scale* precision manufacture.
- A series of "clean rooms" for assembly of missile components. These rooms are dust-proof, temperature and humidity controlled areas with full environmental control procedures.
- Complete, elaborate environmental and other test facilities.



Giant centrifuge in special building at Ford Instrument can attain 60G's. Complete stable platforms—as well as components—are tested in this unit.



Vibration testing of missile component. Such tests duplicate inflight environments that components undergo when missiles are fired.

A special machine is used to mill irregular internal contours by an "electrical discharge" method, with extreme dimensional accuracy.

Technician grinds gyro part to a length within 20 millionths of an inch—typical of tolerances being met in missile work at Ford Instrument.

Engineering Shop. This shop makes breadboard models and other experimental products. It has much specialized equipment, e.g., toroidal coil winders, lapping equipment, in addition to standard machine tools.

Over four decades

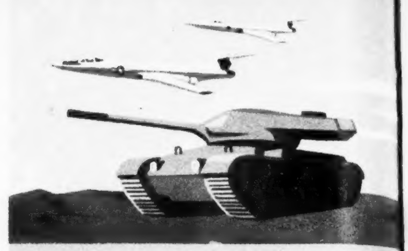
of exacting weapons

control systems

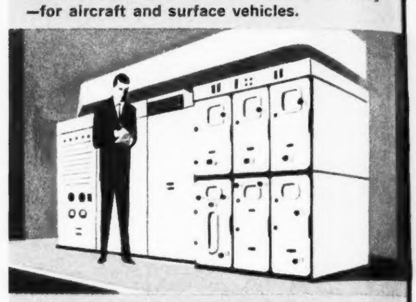
FORD INSTRUMENT related experience . . .

Ford Instrument Co. has been devoted to weapons control since its inception, originally pioneering computers and other automatic equipment for direction and control of naval gunfire. Today, Ford Instrument develops and produces equipment of wide variety for every branch of the armed forces and the U. S. Atomic Energy Commission, both directly and as a subcontractor through major manufacturers. The illustrations here give a small cross-section of the many hundreds of activities (other than missile) under way at Ford Instrument.

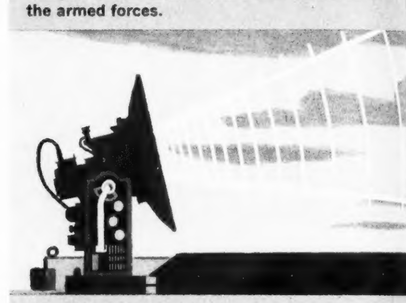
Ford Instrument welcomes inquiries from responsible contracting agencies in government or industry. Liaison engineers are available to discuss specialized requirements or to assist in generation of requirements for any service.



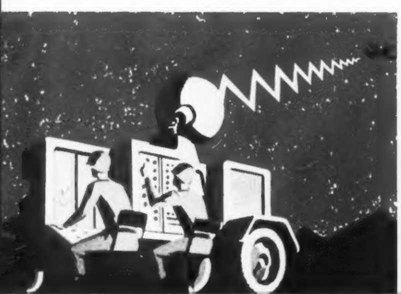
Navigation computers. Ford Instrument develops and produces automatic navigation systems for both U. S. Air Force and U. S. Army—for aircraft and surface vehicles.



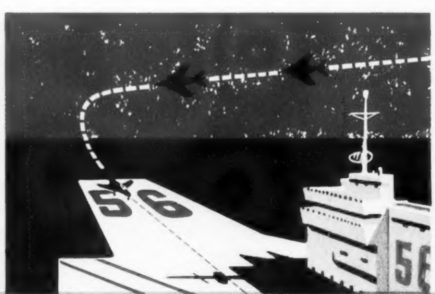
Special-purpose computers. Ford Instrument computers are in wide use in all branches of the armed forces.



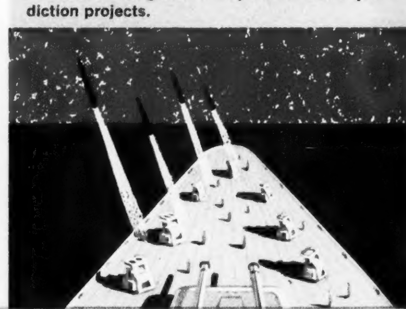
Telemetering and radar systems. A variety of projects at Ford Instrument range from "data-link" and other high frequency techniques—to radar intelligence interpretation and prediction projects.



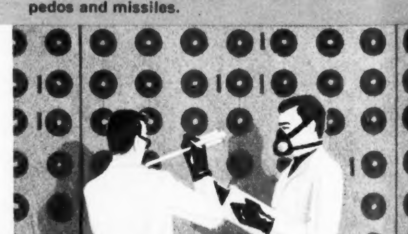
Drone control. Battlefield surveillance aircraft are remotely controlled by Ford Instrument system (radar, transmitting, computing and plotting equipment).



Mission control systems. Latest results of operational research and linear programming theory are implemented by Ford Instrument techniques.



Rocket and gunfire control. Ford Instrument has developed and produced a tremendous variety of fire control equipment for naval and land-based guns and rockets, as well as torpedos and missiles.



Nuclear development. Ford Instrument nuclear activities include reactor designs, instrumentation, control systems (including studies of digital techniques in reactor control) and highly classified weapons projects.

FORD INSTRUMENT CO.

DIVISION OF SPERRY RAND CORPORATION

31-10 Thomson Avenue, Long Island City 1, New York

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Dayton, Ohio	Huntsville, Ala.	Beverly Hills, Calif.

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10,000th ARS Member

(CONTINUED FROM PAGE 36)

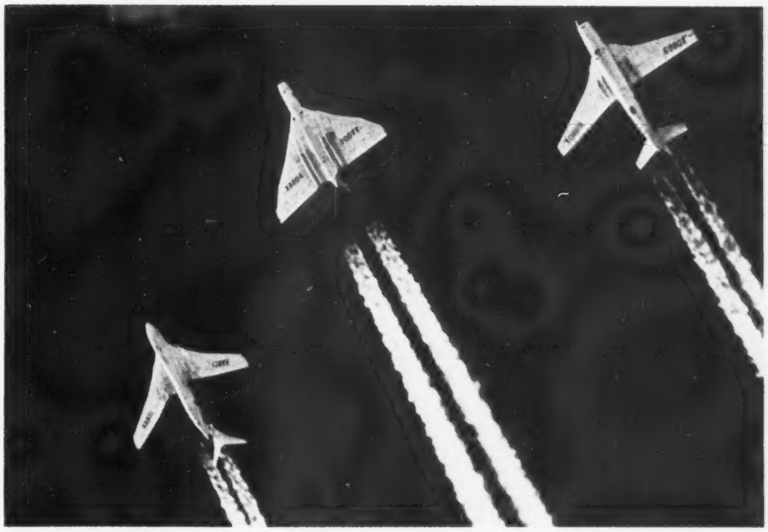
an interest in active sports, Dick bowls with a Convair league team and has a 140 average, shoots an occasional round of golf while insisting he's strictly in the duffer class, and likes to swim.

A hi-fi enthusiast, he prefers mood music, the classics and semi-classics. He also is an avid gun collector, and already possesses more than just a modest array of pistols and rifles. An interest in languages dates back to his youth, when he studied Spanish in high school. He added courses in French and German at the university, and has also studied Italian.

The Moores, with their two-year old daughter, are apartment dwellers, but have somehow found the time and space to take up dog breeding, with a prize dachshund already having one litter to her credit. Dick also finds himself pressed into service as a cook, frequently holding forth at the family's backyard barbecue grill.

Dick's interest in the Society was generated by his attendance at the joint ARS-ASME Aviation Conference in Dallas earlier this year. His application arrived in National Headquarters not long after the meeting, and he was presented with the 10,000th membership card at the recent Detroit meeting by ARS National President George P. Sutton.

Whether or not Dick Moore is the typical ARS member or not is beside the point. What is important is his selection of ARS as the society in which he thinks he belongs. His belief is borne out by the 4000 or so "Dick Moores" who have joined ARS in the past year.



Britain's V-Bombers

Britain's deterrent air power rests on these three advanced jets known as V-bombers. Left to right: Handley Page Victor, Avro Vulcan and Vickers Valiant.

Civilian Space Flight Program

(CONTINUED FROM PAGE 31)

agement of so large a contract research program requires ease of liaison with AEC, the Weather Bureau, the National Science Foundation, the National Academy of Sciences, and others of the scientific community. Also, most industrial concerns maintain Washington representatives, thus enabling easy liaison with the groups who will be performing substantial amounts of work under contract to NASA.

As planned, the work in space science will include use of unmanned satellites, lunar probes and such supplemental vertical probes as sounding rockets. Consideration was given to the U.S. IGY earth satellite and sounding rocket program; the Defense Department space satellite program, especially that under the direction of the Advanced Research Projects Agency (ARPA); the satellite vehicles that can be launched in the near future, using the rocket motors already developed for our ballistic missile program; and, finally, the scientific experiments recommended by the nation's scientific community.

Program's Goal

A prime goal of the space technology program is development of a rocket motor with thrust of 1 to $1^1/_2$ million lbs. Such a motor would permit putting into orbit some 40,000 lbs of payload. It would permit putting a payload of 10,000 lbs into an orbit that would circumnavigate the moon. Development of such a rocket motor may cost $250 million or more, and may require five or six years. Such a project is likely to be supported both by NASA and DOD.

Support by NASA is also planned for development of high energy fuels and nuclear engines for space travel requirements, and, on a longer time scale, such electric propulsion systems as ion jets. There are, of course, many other aspects of space technology that require early attention.

Turning to the ultimate goal, manned flight leading to exploration of the solar system, rocket motors already developed for ballistic missiles are powerful enough to take the first real step, putting a man-carrying device into orbit at altitudes up to, say, 125 nautical miles. By the time, in the not-too-distant future, that other necessary arrangements have been completed to take such a step into space, it may be expected that the reliability of these motors will be up to the task. Meantime, such problems as launching and re-entry accelerations, re-entry heating, vehicle guidance and vehicle stabilization, must be solved. Work is already in progress on these problems.

Firings of large satellites by NASA will probably be done by the same people who now are firing satellites at Cape Canaveral in Florida and at Vandenberg AFB (Camp Cooke) in California. For the launching of smaller satellites, weighing up to 100 lb or so, it is planned to make use of expanded facilities at Wallops Island, Va., on the Atlantic Coast. Here, since 1945, the NACA has had a small range for the firing of rocket-propelled models. Some 10,000 firings have been accomplished during the 13 years the range has been used, with an average success higher than 90 per cent. The principal reason for expanded use of the Wallops Island facility is to avoid tying up an enormously complicated and expensive range, such as Canaveral, for some tasks that can be readily accomplished elsewhere. There is no sense in using

10-ton trucks to carry 10-lb packages around town.

In the Space Act which established NASA, our national space objectives are clearly stated. They warrant inclusion here:

"The Congress hereby declares that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind . . . The aeronautical and space activities of the United States shall be conducted so as to contribute materially to one or more of the following objectives: (1) The expansion of human knowledge of phenomena in the atmosphere and space; (2) the improvement of the usefulness, performance, speed, safety and efficiency of aeronautical and space vehicles; (3) the development and operation of vehicles capable of carrying instruments, equipment, supplies and living organisms through space; (4) the establishment of long-range studies of the potential benefits to be gained from, the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes; (5) the preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere; (6) the making available to agencies directly concerned with national defense of discoveries that have military value or significance, and the furnishing by such agencies, to the civilian agency established to direct and control nonmilitary aeronautical and space activities, of information as to discoveries which have value or significance to that agency; (7) cooperation by the U.S. with other nations and groups of nations in work done pursuant to this Act and in the peaceful application of the results thereof; and (8) the most effective utilization of the scientific and engineering resources of the United States in order to avoid unnecessary duplication of effort, facilities and equipment."

In the Senate hearings on the nominations of Dr. Glennan and myself, Dr. Glennan was asked if he thought that American efforts on space matters were "moving as fast as you think they ought to be moved." "They are not," he replied, but later added: "It seems to me that this is an Act under which we can get ahead . . . If I had not thought this to be an important activity of this nation, I should not have accepted this appointment . . ."

I am in hearty agreement with these views.


AUXILIARY POWER
for the U.S. Army's deadly
NIKE HERCULES
AiResearch units power the controls of America's most potent defense weapons
U.S.ARMY
Key defense and population centers are now being ringed with batteries of Army Nike Hercules missiles to deter or destroy aggressors. *Supplying power for flight controls* is the AiResearch auxiliary power unit pictured above, now in production.
As a member of the Army-industry team producing the Nike Hercules (Army Ordnance, Western Electric-Bell Telephone Laboratories and Douglas Aircraft), AiResearch was chosen to design, develop and manufacture this vital accessory power source for the missile because of nearly two decades of experience in lightweight turbomachinery.
This experience includes applications utilizing solid propellants, liquid mono-propellants, bi-propellants, atomic power, cryogenic gases as well as gasoline and air. AiResearch's ability for high capacity production as well as in research and development, made it the logical choice.
Garrett's AiResearch divisions have also designed systems and components for 18 other missiles and rockets in the U.S. defense arsenal.
We invite your inquiries.

Human Factors

(CONTINUED FROM PAGE 59)

with life experiments in laboratories working with satellites.

A second well-planned symposium was the one on submarine and space medicine sponsored jointly by the Institute of Biological Sciences and ARPA, at the invitation of the Naval Medical Research Lab in New London, Conn. This conference, attended by persons from all over the country, as well as from abroad, covered in detail the full range of problems common to both areas.

Finally, we saw the establishment of agencies with special responsibilities for planning man-in-space programs—NASA and ARPA. Within the services, moreover, there have been major efforts to organize study and experimentation directed toward manned space flight, as, for instance, the forming of the Bio-Astronautics Div. at BMD under the direction of General Don Flickinger.

Naval Powder Factory Gets New Name

The name of the Naval Powder Factory, Indian Head, Md., has been changed to the U.S. Naval Propellant Plant to reflect the shift in its activities from producing conventional ammunition to the forming of propellant charges for such missiles as Terrier, Talos, Sidewinder, Weapon A and Mighty Mouse.

Army Studying Micrometeorology

The Army Electronic Proving Ground, Fort Huachuca, Ariz., has begun a major study of local weather variations and their effect on the launching of missiles, use of radar and local fallout from atomic weapons. The Army will hold a symposium for physicists, chemists, mathematicians and agriculturists as well as meteorologists at AEPG in December. AEPG is already working under contract with the Universities of Wisconsin and Arizona in weather research.

Atomic Energy Papers Available

A listing of technical papers presented by American scientists at the 2nd International UN Conference on Peaceful Uses of Atomic Energy is available from OTS, Dept. of Commerce, for 25 cents.

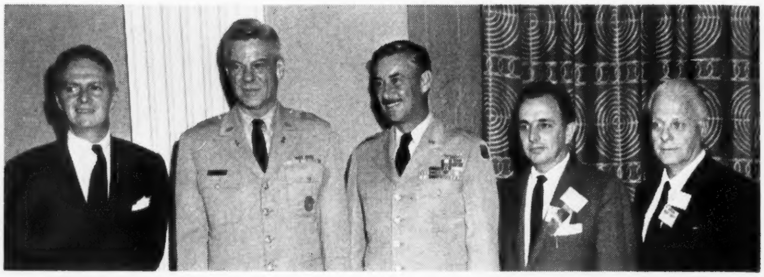
ARS news

Fall Meeting in Detroit Draws Attendance of 1500

DETROIT—Formula for a successful meeting: Start by planning your program a year ahead of time and selecting an outstanding group of technical sessions; add a prominent group of luncheon and banquet speakers; mix with a special forum on an intriguing topic, an exhibit and a field trip; and top the whole thing off with an all-out effort by the meeting committee and the entire local section.

That's all there is to it. The proof? The outstandingly successful ARS Fall Meeting held at the Hotel Statler here Sept. 15–18, which drew an attendance of more than 1500, not including a large number of unregistered guests and exhibit visitors.

Highlights of the meeting were almost too numerous to mention, beginning with an official proclamation by Detroit's Mayor making the city "Missiletown, USA" for a week and the setting up of outdoor exhibits, including a complete Jupiter-C vehicle, along the length of Washington Boulevard; and running through two banquets and a luncheon; seven technical sessions, including classified sessions on two "hot" subjects—monopropellants and nonpropulsive power; a forum on the impact of astronautics on industry which brought together an outstanding panel of engineering, military and industry leaders; a special exhibit of astronautical and missile components and equipment made by local contractors; and winding up with a classified tour of the Chrysler Corp. Missile Div. facilities on the last day.



T. F. Morrow of Chrysler, Maj. Gen. John H. Hinrichs, Maj. Gen. John B. Medaris, Fred Klemach and Carl Bachle gather before luncheon at which Gen. Hinrichs was featured speaker.

C. A. Brady of Chrysler, Maj. Gen. John B. Medaris and T. F. Morrow pose in front of Jupiter nose cone, displayed publicly for first time at meeting. Brady holds citation he received at the banquet.

J. Frank Forster of Vickers, Inc., introduces speaker at luncheon.

The meeting got underway on Monday evening, Sept. 15, with a reception sponsored by ARS Corporate Members from the Detroit area, with technical sessions beginning the following morning. One of these sessions, on the subject of long-range missile components, produced an interesting discussion of the relative merits and demerits of floated and air-bearing gyros, with W. G. Denhard, assistant director of the MIT Instrumentation Lab, plumping for the former, and H. C. Rothe, chief of the ABMA Gyro and Stabilizer Branch, upholding the latter.

The luncheon speaker the same day was AF Chief Scientist George E. Valley, who took the opportunity to review the recent DOD reorganization from the standpoint of its effect on this nation's research and development effort. While professing himself generally pleased with what has been done, Dr. Valley noted that there has been no significant increase in government R&D budgets, and Congress appears to be of the opinion that the new organizations charged with direction of the R&D effort will be able to produce more for the same amount of money.

The forum that afternoon produced one of the largest turnouts of the entire meeting, attracting many ARS members, as well as a large delegation from local advertising agencies and component and equipment manufacturers. Harlan H. Hatcher, president of the Univ. of Michigan, chaired the session, with Wilbur Nelson, of the University's Aeronautical Engineering Dept., acting as co-chairman. Panel members were Willis Hawkins, general manager, Lockheed Missile System Div.; Brig. Gen. Homer Boushey, first AF Director of Advanced Technology; Karel J. Bossart, technical director, Convair-Astronautics; Richard Cesaro, ARPA; Dr. Valley; and John De Nike, manager of advance design, The Martin Co.

Army R&D Chief, Lt. Gen. Arthur G. Trudeau, banquet speaker, mulls over a question at press conference.

The forum got underway with brief statements by each of the panel members and proceeded to a full-scale discussion of what effect space flight would have on industry during the

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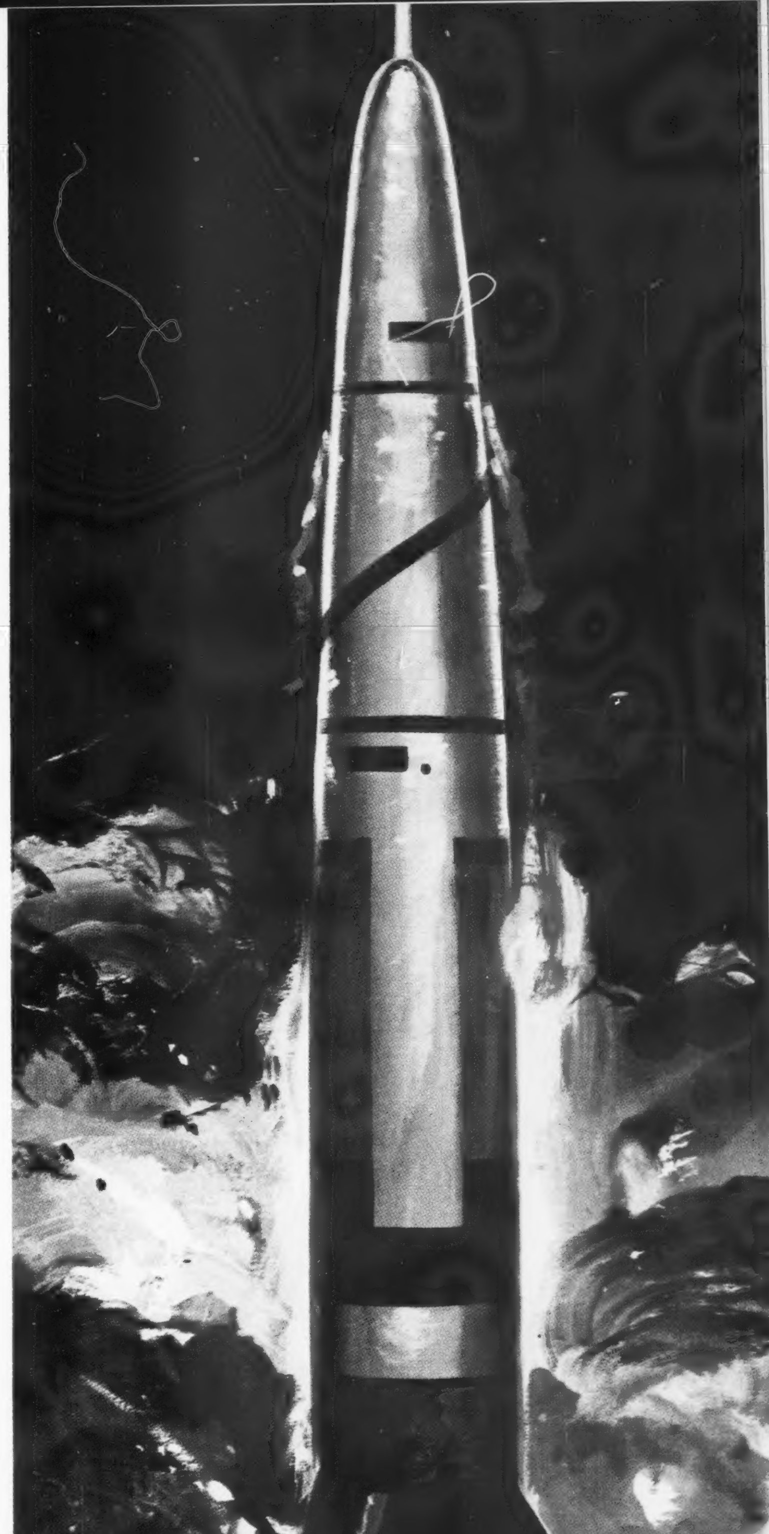

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Technical sessions were all well attended. . . as were the luncheons.

years that lie ahead. The consensus: That, while astronautics may grow into a $4 billion market and employ as many as 500,000 people in 15 years, it will never quite make the "big business" category in the currently accepted sense of the term.

Bossart, for example, thought that astronautics would never become a mass production industry, noting that manufacturing would for the foreseeable future be limited to one-of-a-kind vehicles. Only some as yet unforeseen breakthrough in propulsion could negate this, he added. He also pointed out the high cost and low return, in terms of dollars, that could be expected from any efforts in this area, and anticipated that major emphasis would continue to be placed on R&D work for some time to come.

Dr. Valley concurred with Bossart, noting that during the next 10 years space flight will be devoted to basic research on space itself and the nearer planets, and that specialized vehicles would be needed for such missions. He felt that industry would profit mostly from the indirect results of space flight, which might give rise to a host of processes and equipment useful for other than astronautical purposes.

Bossart could not see the first space vehicles benefiting the military to any particular extent, but this brought a protest from Gen. Boushey and Cesaro, who felt that improved communications, navigation, weather forecasting and detection and warning systems of definite benefit to the military would result.

Cesaro saw propulsion as the key to space flight, anticipating that the first space missions would be accomplished through use of an ICBM first stage in combination with upper stages using high energy fuels. Later missions would use vehicles made up of a 1-million or 1.5 million-lb thrust booster with an ICBM as the second stage. Finally, vehicles using clustered 1.5 million-lb thrust engines as a booster would penetrate into deep space.

De Nike also disagreed with Bossart on the military value of space flight, seeing definite military advantages in putting a man in space and setting up a manned outpost on the moon, although he admitted it would be extremely difficult to prove the value of such projects now.

Hawkins explored another area in his remarks—that of reliability. He felt that some companies have gone overboard on reliability and pointed out that the main idea was to produce something that worked, and not something that was scientifically perfect. He suggested that many companies might consider the establishments of "vice-presidents in charge of simplicity."

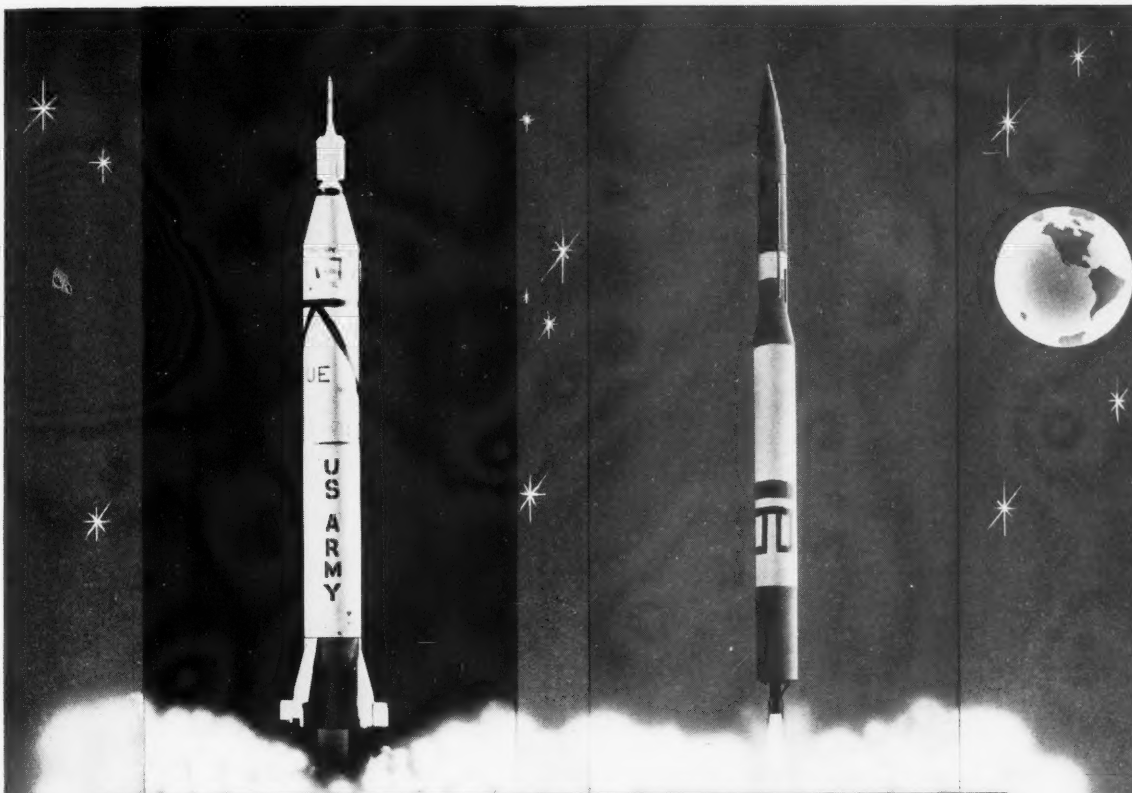
The Confidential session on monopropellants and the Secret session on nonpropulsive power for missiles each drew an attendance of over 500, while nonclassified sessions on ballistic missile manufacturing and missile logistics and operations, scheduled opposite the two classified sessions, also were well attended. Other technical sessions were devoted to small missile production developments and controls for supersonic airbreathing engines.

At the luncheon on Wednesday, Sept. 17, Maj. Gen. J. H. Hinrichs,

George Valley's luncheon address was one of the meeting highlights.

Press conference was also held by Maj. Gen. John B. Medaris.

Fred Klemach, G. Edward Pendray, Brig. Gen. Homer Boushey, George Valley, Harlan Hatcher and Lovell Lawrence in pre-forum get-together.


US ARMY

Panel for the forum on "Impact of Space Flight on Industry." Left to right, Richard Cesaro, George Valley, Brig. Gen. Homer Boushey, Harlan Hatcher, Karel Bossart, Willis Hawkins and John De Nike.

Army Chief of Ordnance, estimated that the increase in business for industry through acceleration of this country's missile and space flight programs will be about 5 to 10 per cent over the next two or three years.

Banquet speaker was Lt. Gen. Arthur G. Trudeau, Army Chief of Research and Development, who emphasized the need for cutting the lead time between conception of a weapon system and development of a prototype, and formulating an improved means for selecting among programs deserving of primary emphasis. He also called for further acceleration of our missile and astronautics program and flatly declared that the Army has "a definite military requirement for space."

C. A. Brady, general manager of Chrysler Missile Div.; Fred Klemach of Vickers; and David N. Buell of Chrysler received special ARS citations at the banquet.

All through the meeting, the exhibit of missile and astronautical space flight components and equipment manufactured by Detroit area companies drew large crowds. An "extra added attraction" at the meeting was the first public display of a full-size Jupiter reentry nose cone. Top military brass, as well as industry leaders, abounded at the meeting.

Success of the meeting was due in no small part to the tremendous efforts of the Meeting Executive Committee —Lovell Lawrence of Chrysler Missile Div.; Charles W. Tait of Wyandotte Chemical, president of the Detroit Section; and Fred Klemach of Vickers, general chairman of the meeting. A vote of thanks is also due Chuck Gibson, Ed Nielsen, Dave Buell, Mrs. C. W. Williams, Athol Denham and all the other Detroit Section members who gave wholeheartedly of their time and effort in an all-out attempt to make the meeting the outstanding success it was.

—**Irwin Hersey**

Nine More Companies Become ARS Members

Nine more companies have become corporate members of the AMERICAN ROCKET SOCIETY. The companies, their areas of activity and those named to represent them in Society activities are:

Allied Chemical Corp., New York, N.Y. represented by Glenn A. Nesty, vice-president; A. H. Patton, manager, Product Development, General Chemical Div.; R. M. Jones, manager, Product Development, Nitrogen Div.; P. A. Elias, market analyst, Plastics and Coal Chemicals Div.; and D. H. Ross, director, Product Development, Solvay Process Div.

Arthur D. Little, Inc., Cambridge, Mass., consulting services in field of missiles to industry and Government. Named to represent the company in ARS are: Donald C. Bowersock Jr.; William E. Gordon; John T. Harvell; Theodore J. Nussdorfer; and John L. Rothery.

Baldwin - Lima - Hamilton Corp., Philadelphia, Pa., represented by James T. Scriven, supervisor, Special Products Sales, E.&I. Div.; Tracy C. Dickson, project engineer, E.&I. Div.; H. P. Vassar, sales manager, Missile Projects, Loewy-Hydropress Div.; A. Zandel, chief engineer, Special Machinery, Loewy-Hydropress Div.; and J. L. Lebach, project engineer, Loewy-Hydropress Div.

Goodyear Aircraft Corp., Akron, Ohio, engaged in the production of rocket motor hardware, propulsion system research and development, and missile design, development and production. Representing the company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On the calendar

1958

Nov. 6–7	National Specialist Meeting on Dynamics and Aeroelasticity, sponsored by IAS Texas Section, Texas Hotel, Ft. Worth, Tex.
Nov. 6–7	5th Annual Meeting of the Professional Group on Nuclear Science, Villa Hotel, San Mateo, Calif.
Nov. 10–12	AF School of Aviation Medicine-Southwest Research Institute Space Symposium, Hilton Hotel, San Antonio, Tex.
Nov. 17–21	**ARS 13th Annual Meeting, Hotel Statler, New York, N.Y.**
Dec. 2–4	3rd Electronic Industries Assn. Conference on Reliable Electrical Connections, Statler-Hilton Hotel, Dallas, Tex.
Dec. 3–4	2nd National Symposium on Global Communications, jointly sponsored by IRE and AIEE, Colonial Inn, Desert Ranch, St. Petersburg Beach, Fla.
Dec. 17	Wright Brothers Lecture, sponsored by IAS, Natural History Bldg., Smithsonian Institution, Washington, D.C.
Dec. 26–31	125th Annual Meeting of the American Assn. for the Advancement of Science, Washington, D.C.

1959

Jan. 26–29	27th Annual IAS Meeting, Sheraton-Astor Hotel, N.Y.C.
Feb. 3–5	14th Annual Technical and Management Conference of the Reinforced Plastics Div. of The Society of the Plastics Industry, Edgewater Beach Hotel, Chicago.
March 19–20	Flight Propulsion Meeting, sponsored by IAS, Hotel Carter, Cleveland, Ohio.
March 23–25	**ARS Spring Meeting, Daytona Beach, Fla.**
April 5–10	Fifth Nuclear Congress of Engineers Joint Council, Cleveland Auditorium, Ohio.
April 6–10	40th Annual Convention of the American Welding Society, Chicago.
May 25–27	**National Telemetering Conference, co-sponsored by ARS, AIEE, IAS, and ISA, Denver, Colo.**
June 8–11	**ARS Semi-Annual Meeting, San Diego, Calif.**
June 11–13	1959 Heat Transfer and Fluid Mechanics Institute, Univ. of Calif., Los Angeles.
Aug. 24–26	**ARS Gas Dynamics Symposium, Northwestern Univ., Evanston, Ill.**
Sept. 13–20	**10th Annual International Astronautical Federation Congress, London, England.**
Nov. 16–20	**ARS 14th Annual Meeting, Washington, D.C.**

in ARS are: J. S. Feldscher, manager, Rocket Div.; H. L. Flowers, manager, Weapon Systems; D. C. Romick, engineer, Weapon Systems; C. N. Scott, manager, Rocket Engineering; and R. E. Stankard, staff representative, Weapon Systems Div.

International Business Machines, New York, N.Y., represented by H. R. J. Grosch, assistant to the director, Marketing Programs; C. C. Hurd, director of automation research; T. W. Luke, manager of Market Development, Military Product Div.; and C. R. DeCarlo, director of marketing programs.

Indiana Gear Works, Inc., Indianapolis, Ind., engaged in the development and production of ultra-precise gear trains for liquid propellant rocket engines. Named to represent the company in ARS are: John L. Buehler, president; T .M. Englehart, vice-president; Harvey U. Gill, sales manager; Lawrence W. Werner Jr., West Coast sales engineer; and Boyd McKinney, assistant to the sales manager.

National Carbon Co., New York, N.Y., represented by Dario Domizi, manager, Ordnance Products Market Div.; Curry E. Ford, marketing manager, Industrial New Products; James G. Kemp, group leader, Development; Carl A. Odening, technical director, Industrial Products; and Herbert N. Townsend, assistant manager, Ordnance Products Market Div.

Rohr Aircraft Co., Chula Vista, Calif., represented by J. E. Rheim, president and general manager; A. F. Kitchin, vice-president, Administration; B. F. Raynes, vice-president, Manufacturing; F. E. McCreery, vice-president, Engineering; and C. E. Barnes, vice-president and plant manager.

The Talco Engineering Co., Mesa, Arizona, engaged in research, development and manufacture of ballistic devices and rocket motors for use in guided missiles, aircraft and related fields. Named to represent the company in ARS are: F. G. Talley, president; G. E. Hirt, vice-president; Jerome Belsky, assistant to the president; and S. E. Danyow, manager.

Eighth IAF Congress Proceedings Available

The full proceedings of the Eighth International Astronautical Congress, held last year in Barcelona, are now available. Published by Springer-Verlag, Vienna, the large format, 607-page book is available to ARS members at $23.80, a 20 per cent reduction from the regular price of $29.75. Copies may be purchased through ARS National Headquarters.

SECTIONS

Central Colorado: A dinner meeting was held Sept. 25 to open the new season. Guest speaker was **AF Capt. Joseph Kittinger,** who described his experiences as a balloonist and discussed psychological and physiological aspects of training for space flight.

Columbus: The first fall meeting was held jointly with IAS at the auditorium of the Battelle Memorial Institute Sept. 16. Guest speaker **Robert Lusser** discussed the concept of reliability in missiles and aircraft.

Future meetings are planned for the second Tuesday of each month in the Battelle auditorium.

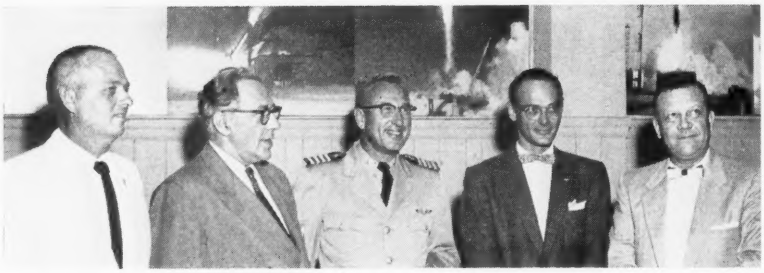
Florida: Members and guests at the August meeting heard two speakers, **Lt. Col. Raymond D. Stephens,** Chief of the Range Safety Div. of the AF Missile Test Center, and **Willy Ley,** noted popularizer of astronautics.

Col. Stephens described devices used to assure safety in testing missiles over the Atlantic missile range. He explained that, although safety practices are aimed at giving as much latitude as possible to missile operations, a missile is not launched if the chances of its hitting a ship are more than one in 100,000. He also reviewed the method of impact prediction in terms of flight-termination time.

Willy Ley talked briefly on the history of astronautics, and then discussed four types of radiation in space and the possibility that a radiation barrier and a magnetic field will be found around the moon. If lunar probes reveal these fields, he noted that an earth satellite with a very elliptical orbit around the earth could give a continuous measurement of radiation with distance from earth. Ley, like many rocket-men, feels the radiation barrier is not unsurmountable.

Continuing its effort to contribute to the education of young people, the section, in cooperation with Brevard County public schools, is giving a series of 11 briefings to local high school science teachers. Section members are instructing the teachers with the aid of lesson plans, slides, actual hardware, field trips and demonstrations.

The teachers are expected to pass-on their newly acquired knowledge to students informally at first, but elementary courses in astronautics for stu-



The August meeting of the Florida section saw Willy Ley, second from left, and Col. Raymond D. Stephens, far right, discuss rocket history and missile safety in range operations, respectively. Section members, left to right, are William Duval, vice-president; Capt. R. F. Sellars, president; and Maj. John Barter, program chairman.

dents might result from the teacher-training program. The tutorial sessions are being tape recorded for possible distribution to all Florida high schools.

The Florida Section, headed by Navy Capt. R. F. Sellars, proposed the teaching program as a means to guide students constructively and safely in the study of rockets and space flight.
—**H. H. Pfeiffer**

Holloman: A brilliant array of speakers has been scheduled for fall programs. In addition to the **Honorable Clinton A. Anderson,** Senator from New Mexico, whose subject is yet unannounced, these prominent scientists will address the section on space topics and technologies: **Benjamin P. Blasingame,** head of the Dept. of Astronautics at the U.S. AF Academy; **Walter Dornberger,** head of the German rocket development program during WW II and now a consultant to Bell Aircraft; **Gerald P. Kuiper** of Yerkes Observatory, one of the world's foremost authorities on planetary astronomy; **William R. Lovelace,** head of the Lovelace Foundation of Albuquerque and one of the fathers of aeromedicine; **Ernst A. Steinhoff,** formerly in charge of guidance and control development for the V-2 and now associate director of the Aerophysics Dev. Corp.; and **Hubertus Strughold,** adviser for research at the USAF School of Aviation Medicine.

New York: Robert C. Baumann, head of Satellite Structure Group of Project Vanguard, will be the guest speaker at the first fall meeting of the Process and Metals Division of the New York Metropolitan Section, to be held Monday, Nov. 17, at 7 p.m., at the Wilkie Memorial Building, 20 West 40 St., in New York.

Princeton: Elected as officers at a recent meeting were Kimball P. Hall, president; David T. Harrje, vice-president; and Robert F. McAlevy III, secretary-treasurer.

St. Louis: The Sept. meeting was held in Crow Hall of Washington University. Guest speaker of the evening was **Leonard Brewer,** project director for rocket engines at Olin-Mathieson's Ordill plant, who discussed the manufacture of solid propellant rocket motors, in particular, the more practical aspects of metal treatment, propellant mixing and deaeration, casting, curing and quality control, from the point of view of the manufacturing engineer. Mr. Brewster's long experience with large rockets made this an interesting and informative session.

CORPORATE MEMBERS

GE, reorganizing its military electronics business, has re-established its missile and Ordnance Systems Dept. as the Missile and Space Vehicle Dept., relieving it of responsibility for operation of the Ordnance Section in Pittsfield, Mass., renamed the Ordnance Dept. of the Defense Electronics Div. The Missile and Space Vehicle Dept. will direct attention exclusively to advanced projects on missiles and space craft.

Douglas Aircraft recently unified all its missile and space activities under one director at the general office level and divided its engineering activity into three major fields—missiles and space systems, transport aircraft and combat aircraft—each with a director reporting to the general director. Also, teamed with Hughes and Food Machinery and Chemical as major subcontractors, Douglas entered a bid for assembly and testing of Minuteman. Douglas has formed a separate Minuteman Div. in its own company and has joined with the other two firms in a general policy board on Minuteman.

Vitro Corp., through its laboratories at Silver Spring, Md., has developed the weapon system for a wire-guided torpedo. Vitro brought together its fire-control system, wire-guidance technology and the Navy's Mark 39 torpedo in a program for Navy BuOrd.

Reaction Motors Div. of Thiokol has established facilities for manufacturing its packaged liquid propellant engine (Guardian) in buildings of Thiokol's Hunter-Bristol Div. at Bristol, Pa., with first deliveries scheduled for next spring.

Callery Chemical expects to complete the $38 million boron-fuel plant at Muskogee, Okla., for the Navy by the end of the year.

Telecomputing's Whittaker Controls Div. has opened its $400,000 cryogenics facility in Los Angeles for environmental and functional testing of gaseous-oxygen flow components under acceleration, vibration, ambient temperature and humidity conditions and for testing electronic, mechanical, pneumatic and hydraulic devices under extreme environmental conditions.

Boeing, through its Systems Management Office, is teamed with these major firms and divisions on Dyna-Soar: Aerojet's Architectural and Engineering Div., administered by Boeing's Pilotless Aircraft Div.—launching-base design; Chance Vought, administered by Boeing's Seattle Div.—pilot capsule and escape mechanisms development; Aerojet's Boost Rocket Div., administered by Boeing's Seattle Div.—boost-rocket systems development; GE—tracking and telemetering system management; Ramo-Wooldridge — reconnaissance-system management; North American's Autonetics Div.—automatic flight and landing system management; North American's Missile Development Div. —first-stage booster development; Goodyear's Avionics and Electronics Div.—radio-guidance system management; and RCA—high resolution radar. Boeing's Seattle Div. will be responsible for assembly of the vehicle, and its Pilotless Aircraft Div. for system demonstration and test.

Fairchild's Guided Missile Div. will be known as the Fairchild Astronautics Div., and the former Aircraft Div. at Hagerstown will be called the Missiles-Aircraft Div. According to Astronautics Div. general manager, Grayson Merrill, these changes indicate the natural extension of products and systems now under development in the respective divisions to expected applications.

Westinghouse has formed an Astronautics Institute to lead its space technology work. The Institute will be headed by Peter Castruccio of the Air Arm Div., who recently received the Baltimore Section's annual award for contributions to rocketry in 1957.

Philco's Government and Industrial Div. has organized a group under Hayden N. Ringer to study and formulate advanced weapon systems.

From Honeywell, a quantitative report o

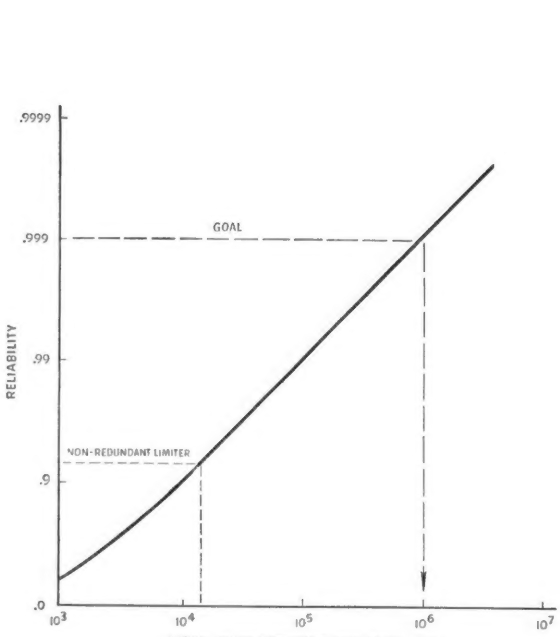
A device may be called "reliable"—but only when reliability is expressed *numerically* can we control and improve it.

The Military doesn't ask for a "reliable" aeronautical device—it asks, for example, for a device with a *.999 Reliability for 1000 hours of operation.* This gives us an expression of Reliability in a quantitative term that is not only meaningful in specifying performance, but also allows us to control and improve Reliability during design and production.

To that end, Honeywell believes that every phase of its operations—planning, design, production, testing, storage, shipment, maintenance and operation in the field—must be included as factors in determining Reliability. It is Honeywell's goal to establish numerical values for as many of these factors as possible.

The following is one example of how far Honeywell has already come in establishing quantitative Reliability practices.

THE PROBLEM: A .999 Reliability for 1000 hours—or 1 failure per million hours



1. Reliability over a 1000-hour operating period as a function of mean time to failure.

Last year Honeywell was called upon to design and manufacture an integrated limiter whose function was to disengage the automatic flight control system of an advanced high-performance aircraft immediately prior to overstress of the airframe. The requirement is a .999 probability that no failures will occur in 1000 hours of flight.

Experience shows that given the mean time between failures the random failure law may be used to predict Reliability. Substitution into the graph at left shows that a limiter which fails on the average of once every 1,000,000 hours will meet the .999 Reliability requirement.

THE DESIGN—To make limiter specifications compatible with the requirement, the following techniques are practiced:

Simplicity—The simpler the design, the less chance for built-in failure mechanisms. As a first approximation, Honeywell uses the chain law of Reliability, which states that the Reliability of an assembly is the product of the Reliabilities of the parts. This allows us to evaluate the effect complexity has on Reliability.

Derating—Used because we know a part's Reliability goes down as stress is raised from zero to the part's rating.

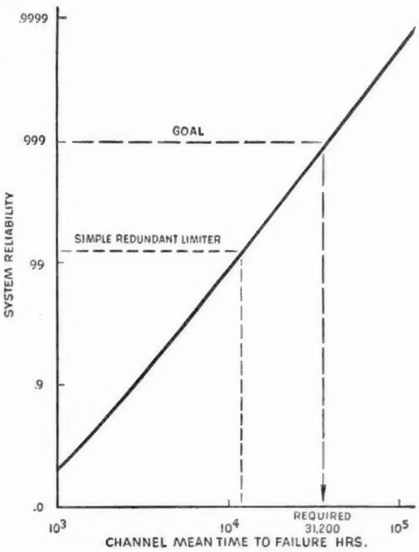
Design Review—Prior to final testing, the device is subjected to a design review by senior designers, a parts application review in which each part is examined by an expert, and a qualification test by an independent expert.

After initial design of the limiter, the mean time between failures for the circuit is computed from the mean time between failures of the parts. At this point, mean time between failures for the limiter is predicted to be 11,000 hours.

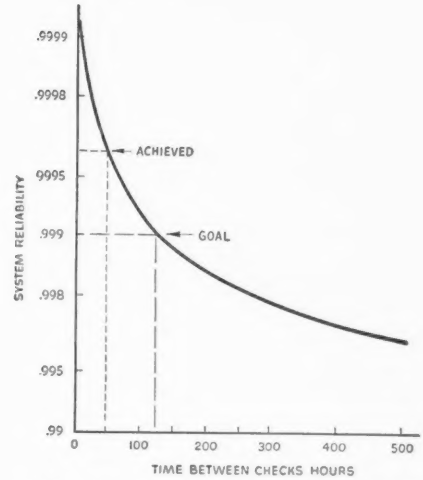
rton reliability

Redundancy is introduced

To raise an 11,000-hour mean time between failures to the required 1,000,000 hours, *two* parallel basic channels, each able to fulfill the complete function alone, are mated. This raises mean time between failures to 131,000 hours, still a long way from the required 1,000,000 hours. The graph (below) shows the relationships and solution.



2. Two channel redundant system reliability over a 1000-hour operating period as a function of channel mean time to failure.



3. Reliability of a redundant system of two 11,000-hour MTBF channels over 1000-hour operating period as a function of the operating time between checks.

Periodic Checks, the Solution

It is found that a periodic check every 50 hours to make sure both channels are operating will result in a mean time between failures of 2,000,000 hours. This meets and even surpasses the requirement. Above is the graphical solution of the computations.

Testing Bears Out the Results

The limiter is tested for 16,000 channel hours with zero failures. Computations show there is only a 10% chance that the Reliability is less than .999 for 1000 hours of limiter operation. This test is conducted under environmental conditions in Honeywell's evaluation laboratories in which any standard environmental requirements can be simulated. Honeywell also utilizes government sled tracks for qualifications involving supersonic environments.

Some Further Results of Honeywell Reliability Methods

The above account is only part of the Honeywell Reliability story. Equally impressive are these examples:

- MG7001 Servo: 10,800 hours mean time between failures based on 500,000 hours experience.
- HG2 Integrator: 35,600 hours mean time between failures.
- Safety and Arming Mechanism: no failures in 50,000 units built.
- Fuze Mechanism: no failures in 1,500,000 units, tested twice each unit.

Results such as these make Honeywell the logical choice for work in the design, development or production of systems and components to meet military specifications. Call or write Honeywell, Military Products Group, 2753 Fourth Avenue, South, Minneapolis 8, Minnesota.

Honeywell

H HONEYWELL *Military Products Group*

Solid Rockets

(CONTINUED FROM PAGE 53)

parts weight reduction and the use of the new propellants have resulted in rockets of minimum weight and size with much-improved propellent mass fractions.

In any large rocket, it is necessary to vector and terminate thrust on command in order to control flight to the target. Since all of the information on vector control and thrust termination is highly classified, it can only be assumed that some of the problems which were obstacles must have been resolved prior to the go-ahead on our large solid rocket programs.

Solids have always been inherently simple to operate, since there are no moving parts or components which must be checked out prior to usage. With this simplicity goes reliability. This includes the double-base family and the composites, namely the potassium and ammonium perchlorates, and the ammonium nitrates with rubber-type fuels. They present only a fire hazard and normally do not detonate, as possibly some of the gun propellants did. These composites, called flexible propellants, being cast-in-case can take all the strains and stresses caused by firing, temperature shocks, handling and shipping conditions, such as dropping more than a few inches, or railroad shocks, just to mention a few. These environmental conditions are mandatory if the rocket is to remain in an instantaneous ready condition after arriving at its destination and being stored until utilized.

High-Thrust Test Firings

There have been reports that static firings of several rockets containing more than 25,000 lb of propellant have been made; and a recent test by Thiokol Chemical Corp. indicates that a rocket delivering 450,000 lb of thrust has been successfully fired. This is only the beginning in large rocket sizes as there seems to be no limit to the thrust and total impulse levels that may be attained with solid rockets, provided that they can be handled at the loading facility and then transported to test sites by highway or rail. If, on the other hand, it is not feasible to make the rocket in one very large unit, clustering of smaller rockets can be utilized safely and efficiently, as demonstrated with Jupiter-C.

It is possible that some of the so-called "exotic propellants" being derived from boron may become realities and put specific impulses over the 300-sec mark. Much private and government money is being spent by our chemical companies in an effort to do just this, but it may take a few years to develop mass production techniques even after the propellant is developed in the laboratory.

All told, if technical progress continues at the same rate as it has in the past two years, we will be ready to boost man into space with solid rockets in the not-too-distant future.

Translated Soviet Publications

The National Science Foundation is making available a number of English translations of key Soviet scientific and technical journals. Meanwhile, the new Foreign Technical Information Center of the Dept. of Commerce's Office of Technical Services provides translations of articles and books, including important sections of the Russian abstract journal. Write these agencies for listings of translations and prices.


NORTH AMERICAN X-15
U.S. AIR FORCE

People in the news

APPOINTMENTS

Donald J. Murphy, former head of Lockheed's Missile System Div., project systems branch, has been named assistant weapon system manager, Lockheed AF satellite program. **Robert M. Salter,** former assistant project manager, has been promoted to the new post of assistant for future applications, and **Thomas P. Higgins,** former missiles and space craft department manager in preliminary design, Burbank plant, will head R&D activities at Van Nuys.

Maj. Gen. Arthur W. Vanaman (USAF-Ret.) has been appointed assistant to the president of Aerojet-General and **Walter L. Tann** has joined the company as special assistant to the vice-president and general manager. **Sidney C. Argyle** has been appointed head of the Avionics Div.'s newly established Optics Dept.

Douglas Aircraft has unified its missile and space activities at the general office level and realigned its Engineering Div. personnel, promoting **Edward F. Burton,** former chief engineer, Santa Monica Div., to director of transport aircraft systems engineering; **Edward H. Heinemann,** chief engineer, El Segundo Div., to director of combat aircraft systems engineering; and **Elmer P. Wheaton,** chief missiles engineer, to director of missiles and space systems engineering. These former assistants of the new directors have been moved up to chief engineers: **Schuyler Kleinhans,** Santa Monica; **L. J. Devlin,** El Segundo; and **R. L. Johnson,** missiles and space systems. **A. D. Jamtaas,** former engineering manager, Charlotte Div., has been upped to chief engineer.

Charles E. Bartley, former president of Grand Central Rocket Co., subsidiary of Food Machinery and Chemical Corp., has been appointed coordinator of FMC's growing interests and activities in the rocket propellant field. He will continue as a board member of Grand Central. **Cledo Brunetti,** executive member of FMC's Ordnance Div., will also serve as acting manager and a vice-president of Grand Central.

Hugh E. Webber, former chief engineer of Sperry's Microwave Electronics Div., has been appointed manager of ground systems at The Martin Co.'s new guided missile and electronics center in Orlando, Fla.

Louis G. Dunn, executive vice-president and general manager, Space Technology Laboratories, and **Ruben F. Mettler,** vice-president and assistant general manager, have been named to the STL board.

Ralph B. Reade, has been named manager of the newly formed Communications Div. of Hughes Aircraft's Airborne Systems Group. He formerly was manager of the RCA Surface Communications Dept.

Col. Harry G. Spillinger, (USAF-Ret.) has been appointed manager of Boeing's newly established Systems Reliability and Safety Control Dept. in the company's Systems Management Office.

Reaction Motors has announced the following appointments: **J. W. Antonides,** director of programs, to the additional duty of assistant general manager, **Richard F. Whitcomb,** manager of public relations, also assistant to the general manager; **Robert M. Lawrence,** controller, and ARS treasurer, to assistant secretary of the parent company, Thiokol Chemical; and **Thomas H. Johnson Jr.,** to director of administration. **E. Dana Gibson,** former program manager, Guardian project, has been made plant manager of the company's new branch manufacturing plant at Bristol, Pa.

Chromalloy Corp. has named **Robert A. Cooley,** former president of Propellex, a newly acquired division, as executive vice-president and director of Chromalloy. Cooley will continue as general manager of Propellex.

Anthony E. Robertson, former vice-president, research and development, Aerial Products, Inc., has joined Thompson Products, Inc. as director of systems work on missiles, Advanced Engineering Group, Tapco Div.

Philco Corp.'s Government and Industrial Div. has formed a new advanced weapon systems group with **Hayden N. Ringer** as manager. Ringer was formerly in charge of the division's missile fuze research, development and production. **Edwin A. Fink,** has been promoted to section manager, missile fuze engineering.

James H. Reid, formerly in charge of electronic systems predesign, Servomechanisms, Inc., has been appointed chief engineer of the company's Subsystems Div.

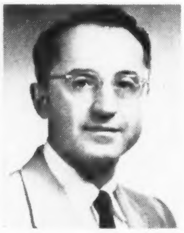
Gerald A. Hoyt, former manager, General Electric's Ordnance Section, has been appointed general manager of the Defense Electronics Div. Ordnance Dept. (formerly the Ordnance Section), while **Edward L. Hulse** will continue as acting general manager of the Missile and Space Vehicle Dept., formerly the Missile and Ordnance Systems Dept.

Benjamin S. Yaffe, former assistant project engineer, Wright Aeronautical Div. Engineering Dept., has been named technical service engineer, Callery Chemical Co. Defense Products Dept.

National Science Foundation has announced the appointment of **Henry S. Odbert,** former chief of the Occupational Analysis Branch of the Personnel Lab., Wright Air Development Center, as program director for psychobiology, Div. of Biological and Medical Sciences. **Arthur H. Waynick,** professor and head of the Electrical Engineering Dept., and director of the Ionosphere Research Lab. at Pennsylvania State Univ., has been ap-


Vanaman


Bartley


Brunetti


Webber


Reade


Robertson


Reid


Yaffee


Manhart


Miller


Reynolds


Schultz

pointed program director for engineering sciences, Div. of Mathematical, Physical and Engineering Sciences.

Charles D. Manhart, former director of military and government sales, Bendix Aviation, has been elected to the new position of vice-president, government relations, Raytheon.

Milton Rosenberg, has been named director, advanced development, Telemeter Magnetics, Inc. He formerly served as senior staff engineer and general manager, Ferromagnetics Div.

E. C. Karnavas has been appointed manager of the Capacitor Dept. of Texas Instruments Semiconductor Components Div.

The Central Engineering Div. of Consolidated Electrodynamics Corp. has upped **Francis T. Greenup,** former chief product engineer, to manager of engineering services and manager of the Alectra Dept. **George M. Slocomb,** former supervisory principal engineer, has been promoted to assistant chief development engineer, and **E. James Penrose** has been named administrative manager.

J. Paul Jordan, has been appointed assistant to the president, Gulton Industries, Inc.

Frank Herbaty and **James S. Rice** have been made managers, plant engineering and manufacturing methods, respectively, at Rohr Aircraft's Chula Vista, Calif., plant.

Albert F. Welch has been appointed head of General Motors Research Lab's new Electronics-Instrumentation Dept.

Lear, Inc., has elected **Roy J. Benecchi** senior vice-president, and **James L. Anast, James P. Brown, K. Robert Hahn** and **Joseph M. Walsh** vice-presidents.

C. L. Randolph, former manager of inorganic boron research at U.S. Borax Research Corp., has been appointed associate director of chemical research.

J. M. Norris, former assistant manager, quality control, Ford Motor Co. Aircraft Engine Div., joins Marquardt Aircraft as factory manager of the company's ramjet manufacturing facility.

Arthur W. Miller has been appointed vice-president and general manager, Ultradyne, Inc.

McLain B. Smith, vice-president and assistant general manager, Data Processing Div. of IBM, has been appointed vice-president and general manager of the division, and a member of the Corporate Management Committee. **Gilbert E. Jones,** former manager of marketing and service, becomes assistant general manager.

Oliver G. Haywood Jr., has been elected vice-president of F. C. Huyck & Sons.

C. J. Breitwieser has been appointed vice-president, engineering and sales, Air Logistics Corp. He will also serve as president of Metrolog Corp., a subsidiary.

Richard R. Fidler has been named manager of the newly Advanced Development-Data Conversion Dept. of the Data Processing Lab at Sylvania Electronic Systems.

Space Electronics Corp. has appointed **W. R. Hughes,** head of engineering, and **Ray W. Sanders,** senior member of the technical staff. Hughes was former director of test support, Space Technology Labs, while Sanders was section director of guided missiles, Gilfillan Brothers, Inc.

Frank T. Majewski, former manager, Rocket Div., M. W. Kellogg Co., has been appointed executive vice-president of the Hicks Corp.

Firewel Co., Inc., Aeronautical Div. has named **Robert F. Zumwalt,** engineering manager of its new Space Technology Dept.

Frank J. Reynolds has been named vice-president for operations, Stavid Engineering, Inc., and will be succeeded by **H. J. Bradfield** as director of contracts and sales. **John H. Hunt,** director of manufacturing, has been elected a vice-president, while **Raymond K. Masnaghetti,** engineering consultant, becomes manager, Research and Analysis Dept., Development Div. **W. A. Schneider,** vice-president, has been appointed director of engineering. **J. L. Schultz,** formerly responsible for design and development of airborne early warning radar projects at General Electric, joins the company as senior scientist.

F. E. Newbold Jr., has been named Fairchild Engine and Airplane Corp. vice-president for corporate planning; **Richard C. Palmer,** vice-president of communications; **James H. Carmichael,** president of the newly formed Commercial Transport Div., and **R. James Pfeiffer,** vice-president, marketing in the new division. **Everard M. Lester,** has been promoted from assistant general manager to general manager of Fairchild Engine Div.

Col. James O. Cobb, has been named to head the new Directorate of Advanced Technology of the AF Missile Development Center, Holloman AFB, N.M.

Harry H. Goode, former Univ. of Michigan professor of electrical engineering, has been appointed technical director of the Bendix Aviation Systems Div.

HONORS

Donald W. Douglas, founder and chief executive officer of Douglas Aircraft Co., has been named recipient of the Franklin Medal, highest award of The Franklin Institute, for "his creative engineering in the field of aeronautical design and in recognition of his engineering genius which has provided inspired leadership for the technical developments of his industrial organization."

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Edited by MORTON ALPERIN, U. S. Air Force Office of Scientific Research, MARVIN STERN, Convair Division of General Dynamics Corp.

The proceedings of the first annual astronautics symposium sponsored jointly by the U.S. Air Force Office of Scientific Research and the Convair Division, General Dynamics Corporation.

Price $15.00

VISTAS IN ASTRONAUTICS, Volume II

Edited by H. F. GREGORY, MORTON ALPERIN, U. S. Air Force Office of Scientific Research.

The proceedings of a conference sponsored by the U.S. Air Force Office of Scientific Research, held at Denver, Colorado, April, 1958. In preparation.

AIR INTAKE PROBLEMS IN SUPERSONIC PROPULSION (AGARDograph 8)

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Interference between the different parts of the engine cannot be neglected in design of air intakes and the testing of the intake alone, without a study of the overall operation of the engine, is apt to lead to wrong estimations of performance. It was the aim of the AGARD Combustion and Propulsion Panel to emphasize this aspect of the air intake problem, by inviting four scientists—specialized in the air intake field—to define their viewpoint on the air intake-engine matching problem. The four lectures in this book were delivered at the Ecole National Supérieure de l'Aeronautique in Paris.

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Translated by Dr. D. J. KESTIN, Brown University, Providence, Rhode Island.

The purpose of this book is to produce the mathematical and physical background of the problems involved in the motion of viscous fluids. Complete, concise, and up-to-date, it is of great value not only to students but also to the practical engineer.

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AGARD-PUBLICATIONS

The following books are published on behalf of the Advisory Group for Aeronautical Research and Development (AGARD), North Atlantic Treaty Organization.

COMBUSTION RESEARCHES AND REVIEWS, 1955
(AGARDograph 9)
Edited by B. P. MULLINS, PH.D., National Gas Turbine Establishment.
Papers read at the 6th and 7th Meeting of the AGARD Combustion Panel.
Price $5.00

COMBUSTION RESEARCHES AND REVIEWS, 1957
(AGARDograph 15)
Edited by B. P. MULLINS, PH.D., and J. FABRI, Paris.
Price $5.60

SELECTED COMBUSTION PROBLEMS I
Edited by Professor W. R. HAWTHORNE, Cambridge and J. FABRI, Office National d'Etudes et de Recherches Aeronautiques, assisted by Dr. D. B. SPALDING, Imperial College, London.
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Behind Red Satellites

(CONTINUED FROM PAGE 33)

German rocket powerplants and guidance and control equipment. They then re-established the German state of the art as it had existed in 1945 by appropriating most of their rocket-test and production facilities and personnel. (It is interesting to note that although most of the Germans were repatriated in 1952, a group of electronics experts was not repatriated until 1958.)

The Soviets not only increased the thrust of the V-2 rocket engine from 25 to 35 metric tons—thereby increasing the range of the missile from 200 to 700 miles—but also developed a super-rocket engine with a thrust of 120 metric tons. They were also interested in designing a rocket engine with a thrust of 250 metric tons, probably as an improvement on the powerplant the Germans had envisioned for their A-10 rocket. Events since August, 1957, seem to indicate that the German A-9/10 project reached fruition in the Soviet ICBM.

By 1949, the Soviets had embarked on an upper-atmosphere research-rocket program that involved the recovery, by parachute, first of test-instrument containers and later of experimental animals. Papers dealing with this program were presented by S. M. Poloskov and B. A. Mirtov and by A. V. Pokrovskii in Paris in December, 1956. According to a Tass report dated March 27, 1958, the single-stage rocket initially used (in May, 1949) attained an altitude of 110 km with an instrument payload of 120 to 130 kg. With improved techniques, larger payloads were sent to higher altitudes. Thus, in May, 1957, a single-stage geophysical rocket raised an instrument payload of 2200 kg to an altitude of 212 km, while on Feb. 21, 1958, an improved single-stage geophysical rocket raised an instrument payload of 1520 kg to a record altitude of 473 km. In each case the payload was recovered by parachute.

One of the meteorological rockets developed by the Soviets, which has been used since 1950, was described in detail by A. M. Kasatkin at the CSAGI Washington conference on rockets and satellites early in October, 1957 (ASTRONAUTICS, November, 1957, page 85). It consists of a solid propellant booster rocket 1.368 m long and weighing 235 kg that burns 82 kg of powder in 2 sec, and a 7-m long sustainer rocket having a starting weight of 680 kg and a kerosene and nitric acid engine that develops a thrust of 1370 kg for 60 sec. At an altitude of about 70 km, the sustainer

rocket separates into two parts, the upper part with instruments attaining an altitude of 80 to 90 km. Both parts descend by parachute and are recovered.

The existence of an official Soviet space flight program may be traced to a significant statement by Academician A. N. Nesmeyanov in his address to the World Peace Council in Vienna on November 27, 1953. Speaking on the problems of international cooperation among scientists, he said: "Science has reached a state when it is feasible to send a stratoplane to the moon, to create an artificial satellite of the earth." As president of the U.S.S.R. Academy of Sciences, Nesmayanov was, of course, familiar with all aspects of Soviet scientific progress. His statement clearly implied that Russian progress in rocket propulsion as of 1953 had made feasible such feats as launching an earth satellite and flying to the moon.

Interplanetary Communications

The seriousness of Soviet interest in space flight became even more apparent on September 24, 1954, when the Presidium of the U.S.S.R. Academy of Sciences established the K. E. Ziolkovski Gold Medal for outstanding work in the field of interplanetary communications, to be awarded every three years, beginning with 1957. The medalist has not been named yet.

At about the same time—but probably somewhat earlier—the Presidium established a permanent Interdepartmental Commission on Interplanetary Communications whose *raison d'etre* is to assist in every way possible the development of Soviet scientific-theoretical and practical work concerning the study of cosmic space and the achievement of space flight. Its specific duties and functions are manifold, and involve the initiation, organization, coordination and popularization of the problems of space flight, as well as the propagandization of the successes achieved.

The Commission joined the International Astronautical Federation in 1957, when, for the first time, a list of 27 members, including eight academicians, was made public. The membership is an impressive one. It comprises some of Russia's—and the world's—top scientists, among whom are L. I. Sedov (chairman), a fluid dynamicist; P. L. Kapitsa, the famed physicist; N. N. Bogolyubov, the mathematical genius who is said to be the Russian counterpart of the late John von Neumann; and V. A. Ambartsumyan, the noted Armenian as-


US AIR FORCE

trophysicist. Also included are a number of high-ranking military officers who are capable scientists in their own right—A. A. Blagonravov, G. I. Pokrovskii, V. F. Bolkhovitinov and Yu. A. Pobedonostsev, for example—all familiar with the military aspects of rocketry and space technology.

The Soviets began to flex their ballistic muscles with the announcement on Aug. 27, 1957 of a successful test in the Soviet Union of an intercontinental ballistic missile capable of carrying a powerful nuclear weapon to any point on the globe. The guidance system was said to be capable of placing the missile on target with an error not exceeding two thousandths of the range, i.e., for a flight range of 10,000 km, the missile would not miss the target by more than 20 km.

G. I. Pokrovskii discusses the problem of attaining the precision required to put ballistic missiles on target in an article entitled "Architecture in the Cosmos" in the December, 1957, issue of *Tekhnika-Molodezhi.* The last-stage engine accelerates the ballistic rocket to its assigned velocity in an "ethereal gun-barrel" or "tunnel" formed by radio beams from three or four radio stations on the ground. At the slightest deviation in direction, the missile enters a zone in which the intensity of the radio waves is greater than in the center of the tunnel. The waves act on the missile's automatic-control instruments and return it to the center of the tunnel. A radio signal shuts off the last-stage engine at the precise moment at which the rocket has attained its predetermined speed.

Propulsive Might

To impress the world that their possession of the ICBM is fact, not fantasy, the Soviets followed through with an unprecedented display of propulsive might by launching, in quick succession, artificial earth satellites on Oct. 4 and Nov. 3, 1957. The size of the Sputnik carrier rockets was evident from the fact that, as K. P. Stanyukovich, a member of the Commission on Interplanetary Communications, pointed out, they could be easily observed with the naked eye as stars of zero or first magnitude, whereas the American satellite Explorer I can be observed as a star of fifth or sixth magnitude only when it is closest to the earth. These differences in stellar magnitude indicate that the reflective areas of the Sputnik carrier rockets were no less than 100 times greater than that of Explorer I.

It is quite likely, therefore, that Sputnik II was no smaller dimensionally than the ballistic rockets displayed in Moscow during the Red Square Parade on Nov. 7, 1957, i.e., about the size of the U.S. Redstone missile. Moreover, since the announced weight of the experimental equipment in Sputnik II was 508.3 kg, the entire device in orbit must have had a mass in the neighborhood of 4 to 6 metric tons.

In the March, 1958, issue of ASTRONAUTICS, page 18, Walter R. Dornberger (of V-2 fame) makes the following observation with regard to the Soviet missile and space-flight program: "Along with the experience they gained in handling long-range rockets, the Russians also got the Peenemuende way of thinking and the schedule for space conquest we had set up as far back as 1942. The satellites are only the first step. Another look at the schedule is all that's necessary to predict what lies ahead."

The schedule that Dornberger and his confreres at Peenemuende had set up was the following 10-point guided-missile and space-flight program:

1. Automatic long-range single-stage rockets (A-4 or V-2)
2. Automatic long-range gliders (A-9B)
3. Manned long-range gliders (A-9B)
4. Automatic multistage rockets (A-9/10)
5. Manned hypersonic gliders (A-9B/10)
6. Unmanned satellites
7. Manned ferry rockets to satellite orbits
8. Manned satellites
9. Automatic space vehicles
10. Manned space vehicles

Since the Soviets are masters in the arts of exploitation and long-range planning, as well as being endowed with a native competence in matters scientific and technological, it is not difficult to imagine the alacrity with which they assimilated the Peenemuende program and adapted it to their own plans for world domination. It is not known how slavishly they are adhering to the Peenemuende program, but it is known that they have already accomplished Points 1, 4 and 6, and have made considerable progress in implementing some of the others.

The Soviet ballistic missile and space flight program is probably somewhat more involved and proliferated than the straightforward program of the Peenemuende group. It undoubtedly follows a logical pattern of development, involving the integration of complex military facilities and skills with the disciplines of the scientific and technical communities. The prob-

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able activities of the Soviet program can be arranged in four general categories that depend, in the main, on theoretical minimum space flight-velocity requirements and on the type of mission to be accomplished.

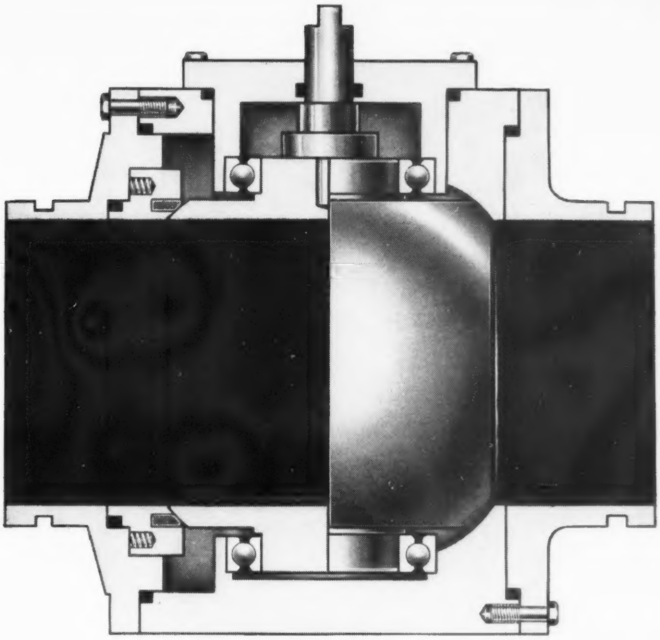
Category I is, in Russian parlance, that of geocosmic flights, or flights from one point of the terrestrial globe to another through cosmic space, for which the flight-velocity requirement is less than orbital (7.9 km/sec). This category is the fundamental one, because the success of the remainder of the program depends on it. Soviet achievements in geocosmic flight consist of their long-range one- and two-stage (i.e., their much-heralded "multistage") ballistic missiles, as well as their geophysical rockets for exploring the upper atmosphere and their biological rockets for studying the behavior of animals during flight to and from the upper atmosphere.

Successful Recoveries

The Soviets have had considerable experience and success with their technique of recovering by parachute test instrument containers and encapsulated experimental animals after rocket flights to altitudes exceeding 100 km. In view of their extensive studies in the various aspects of space medicine and their patent desire to be first to achieve manned space flight, it is reasonable to assume that the Soviets will soon announce the "successful" return of a human passenger from a rocket flight in the Soviet Union.

Category II is that of orbital flight around the earth for which the flight-velocity requirement is between 7.9 km/sec (the so-called first cosmic, or circular, velocity) and 11.2 km/sec (the so-called second cosmic, or "escape," velocity). In this category, the Soviets have achieved three successful launchings that were (a) spectacular primarily because of the size of the packages placed in orbit; (b) significant because of their scientific and military reconnaissance implications; and (c) effective as propaganda devices.

Commenting on the level of developments of technology in the Soviet Union, Khrushchev made the following statement in a speech at Minsk on Jan. 22, 1958: "The whole world was amazed by the fact that the second artificial satellite weighed over six times more than the first one. It weighed more than half a ton. But even this is not the limit. We can double, even more than double, the weight of the satellite, because the Soviet intercontinental rocket has enormous power, which makes it possible for us to launch an even heavier satellite to a still greater height. And we



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shall probably do so!" On May 15, 1958 the Soviets announced that they had placed Sputnik III in orbit. This satellite had a gross weight of 1327 kg, 968 kg of which was instrumentation, somewhat more sophisticated than that in Sputniks I and II.

A. V. Topchiev, chief scientific secretary of the U.S.S.R. Academy of Sciences, in summarizing the first scientific results obtained from the Sputniks I and II before a general assembly of the Academy in March, 1958, formalized Khrushchev's statement in the following terms:

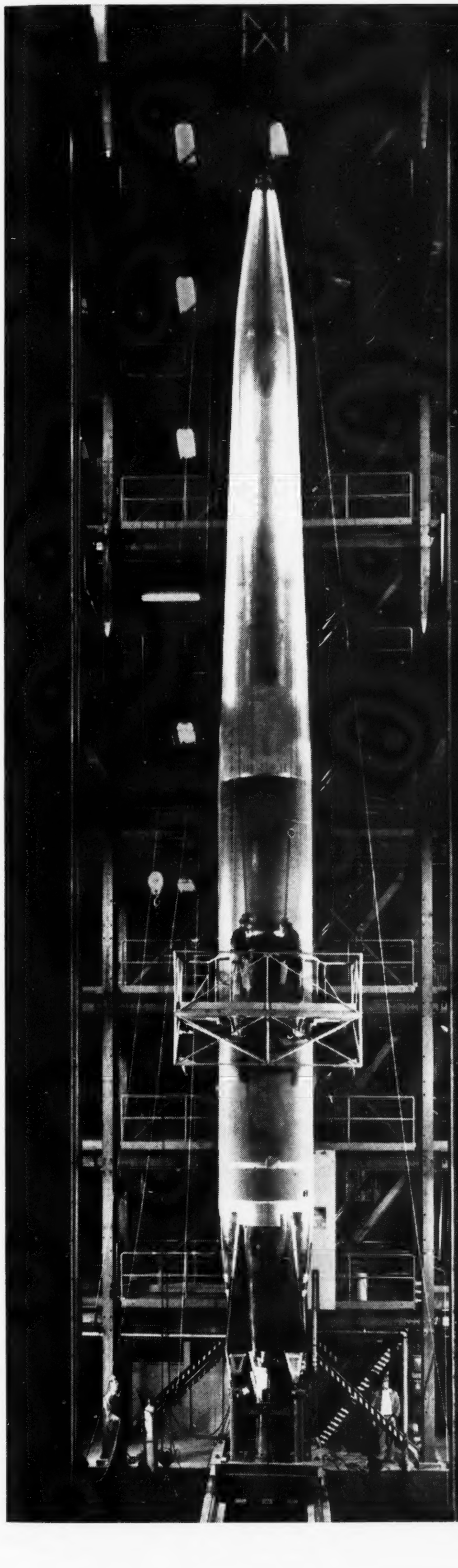
"Using the achievements of native reactive technology which make it possible to raise to a great height and place in orbit containers with scientific apparatus weighing many hundreds of kilograms, our scientists can now raise the most diverse problems in the investigation of the upper layers of the atmosphere and in the region of cosmic space closest to the Earth. It is clear, also, that the solution of the problem of long flights in cosmic space and the attainment of other planets lies only in creating satellites of great weight."

Recovery Techniques

The Soviets are quite aware of the importance of recovering photographic film, instruments and animals from satellites. The examination of such items after orbiting around the earth would be of much greater value than telemetered data. They have discussed the general techniques of recovery and have indicated the existence of various recovery projects. One such project, described in some detail by V. Petrov (*Leningradskaya Pravda*, November 17, 1957), invloves the ejection of a 9.5-kg package from a satellite or carrier rocket at perigee. The package consists of a 5.4-kg retrorocket and a 1.6-kg stainless-steel collapsible sphere, which, when inflated with helium, measures 914 mm in diameter and acts as a drag brake, bringing down to earth, with a terminal velocity of 9 m/sec, a small beacon transmitter and a 227-gm cartridge of exposed film within 20 min after leaving the orbit.

Professor E. K. Federov, commenting on the prospects of recovering satellites, said that the problem is solvable in principle, but as yet has not been solved. At any rate, the availability of such massive Sputniks should afford Soviet scientists and technologists abundant opportunities for testing their recovery techniques.

The ultimate goal in this category is, of course, a manned space station that can serve not only as a space laboratory, but also as an intermediate station for future interplanetary voy-



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ages. The realization of this goal presupposes the implementation of Points 3, 5 and 7 of the Peenemuende program.

Category III is that of lunar flight, for which the minimum flight-velocity requirement is about 11.1 km/sec—slightly less than escape velocity. The Soviets are admittedly deeply engaged in a moon-rocket program. Prof. Stanyukovich has indicated that "if a few more stages were added to modern ballistic rockets, then the last stage of such a rocket would attain a speed of 12 km/sec. This will be quite sufficient to fly to the moon. The first flight to the moon, or circumflight of the moon, will evidently take place within the next few years." But, he added, "before a rocket flies to the moon, a number of artificial satellites will be launched along increasingly elongated elliptical orbits which will draw nearer and nearer to the moon. Instruments installed in such satellites will make it possible to closely study and to photograph the lunar surface, and to learn the nature of its mysterious relief." (*Sovetskaya Aviatsiya*, Jan. 1, 1958.)

Guidance—A Thorn?

Considering the extensive calculations of earth-moon trajectories that have been carried out by V. A. Egorov at the Steklov Mathematics Institute in Moscow and by G. A. Chebotarev at the Institute of Theoretical Astronomy in Leningrad, the Soviets are theoretically well prepared for lunar flights. There seems to be no question of their propulsion capability in this respect, but it remains to be seen whether they have the necessary guidance and control capability to strike the moon.

Category IV is that of interplanetary travel, for which the flight-velocity requirement is considerably greater than escape velocity because of the maneuvers involved in transferring from one planetary orbit to another. Thus, for a space ship to fly with a minimum expenditure of propellants from Earth to Mars along an ellipse mutually tangent to the orbits of both planets, the theoretical minimum velocity required for a "hard" landing (impact) on Mars would be 16.8 km/sec and for a "soft" landing, about 21.8 km/sec. The corresponding theoretical minimum velocities for an Earth-to-Venus flight would be 16.4 and 26.8 km/sec, respectively. The Soviets, aware of the limitations of chemical rockets in this regime, are assertedly looking forward to the role that nuclear engines will play in the future—not only in interplanetary flights, but in geocosmic flights as well.

In view of the variability of interplanetary distance, flights from Earth to other planets will be scheduled not arbitrarily, but in accordance with a rigid timetable based on the most favorable conjunction of the planets with Earth. It is entirely possible that the Soviets, after a successful lunar impact, might attempt to send rockets to Mars and/or Venus along cotangential orbits as mentioned above. The duration of these excursions to Mars and Venus would be 260 and 146 days, respectively. The probable launching dates can be determined by reference to an almanac, e.g., *The American Ephermeris.*

Because the space flight program is inherently connected with the ICBM, Soviet reluctance to discuss certain details of satellite launching is necessarily dictated by military secrecy. It is ironic, however, that the more Sputniks that are placed in orbit, the more the free world will learn about Russian military capabilities in rocketry as a result of direct observation and logical deduction.

For example, Prof. Tadao Takenouchi of the University of Tokyo Astronomical Laboratory, on the basis of Sputnik periods and initial transit times over Moscow, published by Tass, determined the launching time of Sputnik I to be 1921 hours (GMT) Oct. 4, 1957, and that of Sputnik II to be 0232 hours (GMT) Nov. 3, 1957. The intersection of the traces of the two satellites, the elements of whose orbits were determined from observations made in Japan, placed the launching site in the Kyzyl Kum Desert, at a spot with the approximate coordinates 4230 N/6500 E, i.e., about 400 km southeast of the Aral Sea. Data from Sputnik III should help to establish the launching site somewhat more precisely.

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Sputnik Into Space, by M. Vassiliev, The Dial Press, New York, 1958, x + 181 pp. $3.75. With an introduction and notes by William Beller.

This book is a translation from the Italian *Su Sputnik Nel Cosmo* which, in turn, is a translation from the Russian *Puteshestviya v Kosmos* (Travels into the Cosmos). The Russian edition, first published in December, 1955, by the State Publishing House of Literature on Culture and Education (45,000 copies were printed), contains 176 pages, is profusely illustrated in color and black and white, has hard covers, and is priced at 6 rubles, 50 kopecks ($0.65 at book-rate of exchange).

Written in nontechnical language and ostensibly intended for mass consumption and as a harbinger of things to come (i.e., Sputnik), the book is an extremely elementary discourse on the problem of astronautics, or, in Russian parlance, "Interplanetary Communications." For the sake of technical accuracy, the book was edited by Doctor of Physico-Mathematical Sciences V. V. Dobronravov, Professor of Mechanics at the Moscow Higher Technical College (Bauman Institute). Prior to the launching of Sputnik I, a second, enlarged (256 pages) edition of the book was published in 1957, copies of which are, as yet, unavailable in the United States.

According to its Introduction, *Sputnik Into Space* is the English version of the second edition of *Puteshestviya v Kosmos*. Comparison, however, shows it to be an abridgment, loosely translated, of the first Russian edition, from which it differs in two major respects: First, it does not contain the illustrative material that characterizes the original volume. Included, instead, is a set of fourteen photographs—some factual, some fictional—allegedly connected with Soviet rocket and satellite launchings. Second, there is a major difference in the content of Chapter 1. In the original version, this chapter is entitled "Discovery of a Planet" and is a historical sketch of how man determined planet earth's place in the universe. In the present volume, Chapter 1 is entitled "Destination Moon" and simply describes an imaginary manned-rocket flight to the moon.

The subsequent chapters for the most part follow the original material. Chapter 2, "The Universe in Which We Live," discusses the earth's gravitational attraction, the velocity required to overcome it, and some unacceptable methods suggested long ago to accomplish this feat. The contributions made to the science of astronautics by K. E. Tsiolkovskii—his study of liquid rocket propellants, his derivation of the basic formula of rocket motion, his concepts of step rockets and cosmic trains—are delineated in Chapter 3, "The Glorious Undertaking."

The use of air-breathing engines (turbojets and ramjets), as well as rocket engines (both chemical and nuclear), in propelling space vehicles is discussed in Chapter 4, "The Motors of Space Ships." Chapter 5, "In Space," is concerned with such problems as weightlessness, cosmic and solar radiation, nutrition, meteors and interplanetary routes. Chapter 6, "The Stages of the Great Offensive," propounds the exploration of the upper atmosphere by means of balloons and rockets, an imaginary rocket-plane flight from Moscow to Vladivostok, the launching of an artificial earth satellite, the scientific equipment it will contain and projects such as man in space, a manned island in space, rocket transport trains and space laboratories.

Preliminary reconnaissance of the moon by means of lunar rocket probes, the project of lunar surface exploration by means of a radio-controlled tankette, landing on the moon, building a lunar city—all this by 1980—are dealt with in Chapter 7, "The Assault on the Moon." Chapter 8, "Journeys to Outer Space," considers the possibility of rocket exploration of other planets, first Mars and Venus, and later Mercury, Jupiter and the more distant planets. Chapter 9, "Conclusion," discusses the worldwide interest in astronautics, the existence of two astronautic societies in the Soviet Union (the Astronautics Section of the Central Aeroclub and the Interdepartmental Commission on Interplanetary Communications of the U.S.S.R. Academy of Sciences). It also states that "in the U.S.S.R. a review called *Interplanetary Communications* has just been published." Although aborning since 1955, this journal has yet to make its appearance.

Sputnik Into Space contains a disconcertingly large number of errors, some typographical, some due to faulty translation (compounded, of course, by the transition from Russian to Italian to English), and some caused by incorrect conversion of metric units to English units of measurement. The use of "static reactor" instead of "ramjet engine," "combustible element" instead of "oxidizer" and "albumen" instead of "protein" indicates that the translator is unfamiliar with the subject. His use of "cobalt" for "cesium," however, is an inexcusable blunder, as is his dividing 1480 by 2.2 to obtain 512 (p. 32). The editor (William Beller) tries to palliate some of the translational errors by explanatory footnotes. In some cases, he actually blames the author for mistakes and inconsistencies in translation (e.g., footnote 17, p. 109, which was occasioned by the fact that 22 km in the original text has been translated to read 73,000 ft on p. 90 and 70,000 ft on p. 109).

Comparison of the English text with the Russian shows that the translator perpetrated a bit of skullduggery that drew the editor into an unwitting comedy of errors. The section entitled "The Automatic Laboratory in the Sputnik" (pp. 103–108) reads as if it were written after the launching of Sputnik II, whereas it was written in 1955 and refers to satellite projects in the literature at that time—specifically to S. F. Singer's MOUSE. Footnotes 11 to 14 indicate Beller's confused and futile efforts to reconcile the author's satellite specifications (1955) with Soviet Sputnik information published in October, 1957.

In fine, *Puteshestviya v Kosmos* is less beguiling than *Sputnik Into Space*.

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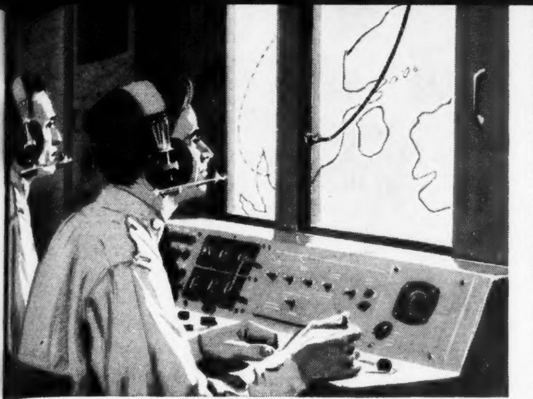
BOOK NOTES

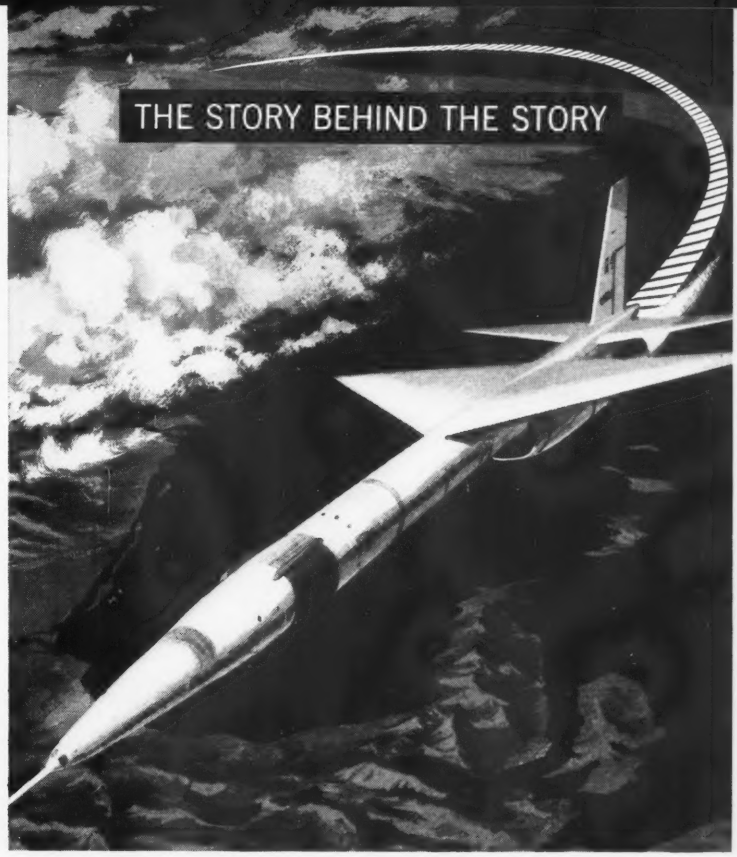
Air Force Report on the Ballistic Missile, edited by Kenneth F. Gantz (338 pages, Doubleday & Co., Garden City, N.Y., 1958, $4), describes the official policies and programs of the U.S. Air Force concerning the technology, logistics and strategy of ballistic missiles, in 12 chapters authored by AF officers, e.g., Col. A. Sheridan on "Impact of the Ballistic Missile on Warfare" and Maj. Gen. Ben I. Funk on "Logistics for the Ballistic Missile." Appendices cover technical aspects of ballistic missiles, targets, reports to Congress and missile terminology.

Guide to Rockets, Missiles and Satellites, by Homer E. Newell (64 pages, Whittlesey House, 330 West 42nd St., New York, 1958, $2.50), presents a fine picture guide to the history and use of rockets in this country for the high school-age youngster. As an introduction, Dr. Newell explains rocket principles and terminology. He describes virtually every rocket and missile in service today, including those for the IGY.



GROUND CONTROL of target drone centers in air-portable van. Men at console maintain control through flight instruments. Path of drone is traced automatically on plotting board at right.

AIR CONTROL relays commands from ground station to drone where distance or terrain block direct beam. Air director may also originate control since it has complete microwave system.



PROBING ANTI-MISSILE DEFENSES, remotely-controlled drone flies at supersonic speed toward target area. Test measures alertness of defense system and speed in launching ground-to-air missile.

GREAT RANGE of Sperry microwave command guidance system is shown in diagram. Ground station (1) controls target drone (2) either directly or through air director (3). Drone draws fire of defense system which launches ground-to-air interceptor missile (4).

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With a range of 400 miles, the Sperry system can guide a drone along a preset course with precise accuracy from a mobile ground control station. It displays a drone's path automatically on a plotting board, receives information continuously from the drone on its speed and other flight conditions, and commands the drone's engine and flight controls. When the earth's curvature or obstructions block the ground signal, the system operates through a director aircraft which is a flying duplicate of the master ground control station.

In working with the Air Force to develop the new system, Sperry made use of its broad experience in gyroscopics and electronics as well as its mastery of microwave radar for guidance and control of missiles and aircraft. Since 1946 Sperry has been designing and producing complete long-range control systems for drones and unmanned aircraft—including the first to fly directly through an atomic cloud.

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Earth Satellite Program

(CONTINUED FROM PAGE 34)

the earth's magnetic field. As these electrons spiral around a line of magnetic flux they descend toward the surface near the magnetic poles. There, by interactions with the atmosphere, they give up their energy.

It is possible that, if this field of electrons exists, it exists only in the region of the earth, or rather in the earth's magnetic field. This sea of electrons is then being constantly drained at the bottom through interactions with the atmosphere and refilled at the top by sporadic bursts from the sun. However, it is equally possible that such a field extends throughout the solar system with a density which falls off only as the distance from the sun.

There are several geophysical consequences of such a field of electrons. Of course, it is reasonable to suppose that the overall field around the earth is neutral; thus there must be as many protons present as electrons. The resulting plasma might seriously perturb the magnetic field of the earth at extreme altitudes. It is likely that this plasma is closely related to geomagnetic storms and aurorae.

Even at heights above 1000 km, there is still some small trace of atmosphere. It is likely that the energy loss from these charged particles interacting with the residual atmosphere contributes significantly, if not dominantly, to the heating of the high atmosphere.

Biological Implications

Of course, there are obvious biological implications from these results. The radiation field inside the Explorer satellites corresponds to about 60 milliroentgens per hour. The maximum safe dose for human beings is approximately 100 milliroentgens per week. Clearly, if a man-carrying vehicle were to make any prolonged flight through this environment, adequate shielding would have to be provided. If the radiation is of the type assumed here, then a lead shield of approximately 1 mm thickness would cut down the radiation dosage by a factor of 10.

Two further experiments are indicated by these results. First, it is necessary to define more precisely the nature of the measured radiation. Also, since no decrease of the radiation level can be observed to the highest altitudes reached by the Explorer satellites (2800 km), it is necessary to make measurements over a range which continues out to extreme distances from the earth.

[*Ed. note:*—Explorer IV was launched July 26 to study further this radiation belt. It carried an unshielded Geiger counter with 1500 times the counting capacity of ones in the previous Explorers, a Geiger counter shielded with $^1/_{16}$ in. of lead, and two scintillation counters (cesium oxide crystals glued to photo-multiplier tubes) to measure the energy flux of the radiation. This satellite, which swung at the maximum some 1350 miles from the earth's surface, indicated that radiation intensity doubled every 60 miles above 250 miles altitude. If the particles involved are protons, radiation was as high as 100 roentgens per hour 1200 miles above South America. The particles, however, have not been identified with certainty, nor has the upper limit of the radiation field.]

The purpose of temperature measurements was to verify design predictions for the satellites. Preliminary calculations indicated that the average surface characteristics achieved by flame spraying stripes of aluminum oxide on the satellite would control its internal temperature within limits established by operating conditions of electronic equipment. To achieve proper operation of this equipment, it was necessary that the temperature remain between −5 and 45 C. Outside these limits, the electronic equipment would cease to operate, but no permanent damage would result unless the temperature rose above 80 C. It was expected, of course, that the shell of the satellite would vary between wider temperature extremes than the instrumentation carried.

Examination of the telemetered data from the satellite has shown that temperatures on various parts of the shell range between −25 and 75 C; temperatures inside the cylindrical section range from 0 to 35 C.

Additional information on the temperature of the components in the nose section of the payload was obtained by observing the frequency of a temperature-sensitive oscillator on one of the telemetering channels. Measurements in the nose cone showed temperature variations from 5 to 40 C. These temperature ranges include all the data taken during the lifetimes of the telemetering systems of both Explorer I and III.

The results of these measurements not only verified the results of the design study but also demonstrated the adequacy of the measurements used to determine radiative properties of the materials involved. These were the measurements of the reflection coefficient taken in a spectrometer with wave lengths ranging from ultraviolet to the far infrared. Apparently

neither the environment encountered during launching nor that during the subsequent orbit produced any changes in the satellite surfaces which would be measured in terms of temperature.

Finally, important measurements have been made of micrometeorite activity. Explorer I contained two devices for this purpose. The first, a microphone mounted against the outer skin of the satellite, detected the impact of micrometeorite particles of approximately 4-micron diam or greater. The second, also carried on Explorer III, consisted of a set of 12 wire gauges, each approximately 1 sq cm in area and wound with two layers of enameled wire 17 microns in diam. Impact by micrometeorites of approximately 10-micron diam or larger causes the fracture of such a gauge.

Data from the high power transmitter of Explorer I indicated that the average influx of particles 4 microns or larger in diam was approximately 10^{-2} per sq m per sec, averaged over a time period from Jan. 31 to Feb. 12.

Establishes Upper Limit

The low power transmitters on both Explorer I and III carried the data from the wire gauges. No more than one of the wire gauges was broken during the lifetime of the telemetering system on Explorer I, and it is possible that none were broken. This information permits an upper limit to be established for the influx of particles 10 microns or more in diam. This limit is 10^{-3} particles per square meter per sec during the lifetime of the experiment, Jan. 31 until April 14.

Data received from Explorer III showed no wire gauges broken until May 6. Then, between 2243 GMT on May 6 and 0232 GMT on May 7, two of the gauges were fractured. This occurrence was followed by an interesting series of events. On May 8 and 9, erratic behavior was observed in one of the telemetering channels on the low power transmitter. After 0415 GMT May 9, no signal at all was observed from this transmitter. During May 10 and 11, the Minitrack receiving stations indicated intermittent operation of the high power transmitter, and after May 11 no further signals were received for several days. After a period of a few days, both transmitters returned to operation. However, the low power transmitter carried no telemetry signal, and the operation of the interrogated beacon was intermittent.

The coincidental failure of these two transmitters is curious. The two units operated quite independently, with separate circuitry and separate power supplies. It was expected that they

might have similar lifetimes, but failure of both within one or two days of each other simply from coincidental power failures is not very likely.

One other piece of information must now be introduced. All the micrometeorite data before this time were taken in a period of normal background activity. No meteor showers were encountered. However, the shower η Aquarides, which has been associated with Haley's Comet, occurs during the early part of May, reaching its most intense activity on about May 5. It is therefore very suggestive that the fracture of two wire gauges and the very nearly coincidental failure of two independent radio systems followed within a few days of the predicted time of this meteor shower. It is reasonable to speculate that some sort of internal damage was caused by the impact of meteorites.

Even the limited amount of information gained from these two experiments has permitted us to extend our knowledge of micrometeorite activity into a range of particle size never before observed.

This is but a fraction of the information that can be expected from the IGY satellites. The most exciting part of the IGY—correlation of rocket, balloon and satellite measurements—is yet to come. Together with radiation measurements by satellites with highly elliptical orbits extending many thousands of miles from the earth, the total digested results of the IGY should give us our first substantial picture of neighboring space.

Rocket Research Program

(CONTINUED FROM PAGE 35)

covering fall, winter and spring, and including both day and night shots, nitric oxide, although a negligible neutral atmospheric constituent, was found to be the predominant positive ion in the E-region of the ionosphere; and atomic oxygen was found to be the predominant positive ion in the F-regions of the ionosphere. Above Ft. Churchill, it was found that, as altitude increases from 100 to 150 to 200 km, the order of relative abundance of positive ions during the daytime changes from (O_2^+, NO^+) to (NO^+, O_2^+, O^+) to (O^+, NO^+, O_2^+). Above Ft. Churchill, the only negative ion detected was NO_2^-.

Above Ft. Churchill, the daytime electron density versus height profile was obtained to 235 km, and was found very similar to the previously observed White Sands daytime profiles; no valley was found between the E- and F-regions in the daytime electron-density curves; and at night less than 2 x 10^4 electrons per cc were found up to 170 km. It was shown that polar blackouts are caused mostly by high absorption in the 60 to 70 km region, where the average electron density at the time of a polar blackout was measured to be 5 x 10^3 electrons per cc. Electron collision frequencies in the 60 to 80 km region were found to be a factor of 3 lower than previously believed, while the condition known as spread-F was observed at night above 190 km, the region being very turbulent and irregular.

The maximum solar x-ray flux observed at the top of the atmosphere at the peak of the solar cycle was 1.0 erg/cm^2/sec, and the maximum Lyman α flux was 6.4 ergs/cm^2/sec. Solar flares produce x-ray flashes of sufficient intensity and short enough wavelength to account for radio fade-out. A stigmatic image of the solar Lyman α line indicated the presence on the disk of the sum of regions of increased intensity.

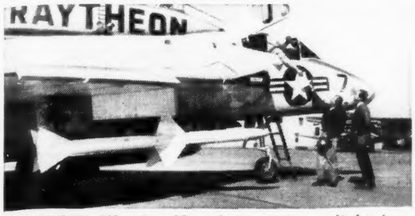
Continuous daylight airglow spectra covering the range from 5600 to 6300 A were obtained at altitudes between 60 and 90 km using photoelectric spectrometers. The Lyman α radiation in the night sky amounted to 10^{-2} erg/cm^2/sec from the entire hemisphere.

In one rocket flight into a visible

Rocket Soundings During First Year of IGY

Location	Type of Rocket	Number
Fort Churchill, Canada	Aerobee	21
	Nike-Cajun	20
White Sands, New Mexico	Aerobee	3
	Nike-Cajun	2
	Nike-ASP	1
San Nicolas Island, Calif.	Nike-Deacon	14
	Nike-ASP	1
Shipboard, Arctic	Rockoon	18
Shipboard, Pacific and Antarctic	Rockoon	36
	Total	116

Raytheon Missile Projects



SPARROW III—the Navy's tenacious, lightning-fast, air-to-air missile—is intended for extensive use by Navy fighter aircraft in fleet air defense. Sparrow III is a Raytheon prime contract.

HAWK—the Army's defense against low-altitude attackers—carries out its destruction in the blind zone of conventional radars. Hawk development and production is under Raytheon prime contract.

TARTAR—A substantial contract for vital electronic controls for this Navy destroyer-launched missile is held by Raytheon. This equipment—a tracking radar and associated units—enables it to "lock on", cling to target's path, despite evasive tactics.

ADVANCED PROJECTS in aeronautical structures as well as missile guidance and control are now underway in Raytheon laboratories. New facilities are continually being added for this work.

PRELIMINARY NEW DESIGNS of tomorrow's missiles will result from the advanced work being done by today's missile engineers. Raytheon plays an important role in this area.

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Individual recognition comes quickly from Raytheon's young, engineer-management—men who are keenly aware of the engineer's needs and contributions to missile progress.

Dynamic Raytheon growth—the fruit of this management's progressive policies—is best illustrated by the fact that Raytheon is already the only electronics company with two prime missile contracts—Navy Sparrow III and Army Hawk.

The next step is up to you. Why not get frank answers and helpful information on the type of job suited to your background and talents, its location, salary and other important details. Write, wire or telephone collect: The number is CRestview 4-7100 in Bedford, Massachusetts. Please ask for J. Clive Enos.

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Excellence in Electronics

aurora, the measured flux of the atomic oxygen emission in the 1300 A region of the ultraviolet was 1.5 x 10^{-2} erg per sq cm per steradian per sec.

The primary source of auroral luminosity and ionization was determined to be energetic electrons incident on the upper atmosphere. Energetic ions were found to be incident on the upper atmosphere in the auroral zone both outside and within visible auroras. Electric currents coincident with visible auroras were found at altitudes of about 120 km by measurements of their magnetic fields. Rocket flights at Ft. Churchill have yielded direct measurements in visual aurorae of the absolute intensities and energy spectra of both electrons and protons; and Rockoon measurements in the Arctic and Antarctic auroral zones have extended knowledge of the latitude distribution of soft radiations—its energy and association with visual aurorae.

A comprehensive investigation of cosmic ray intensity above the atmosphere from Thule, Greenland, to the Antarctic continent has shown the latitude knee to lie between 45 and 50 deg geomagnetic latitude in both hemispheres, the intensity to be the same at extreme northerly and southerly latitudes, and the polar value of intensity to be about 60 per cent of its value at sunspot minimum.

Detailed measurements of the geomagnetic field to altitudes of 120 km have been made by a series of flights of proton-precession magnetometers into the Arctic and Antarctic auroral zones and the equatorial region. The current system of the equatorial electrojet has been confirmed, and its altitude and latitude distribution has been studied.

ICSU Creates New Space Committee

Washington—In a move to perpetuate the IGY cooperative spirit in space exploration on a permanent basis, the International Council of Scientific Unions (ICSU), at its 1958 meeting here, created a new Committee on Space Research (COSPAR) to study a means of achieving international cooperation in space projects by late 1959, when the ICSU will again convene.

COSPAR, an interim committee, has been asked to propose a plan leading to formation of a permanent organ to act as a clearing house for space exploration data. Both the U.S. and the U.S.S.R. joined in unanimous approval of COSPAR, with only West Germany abstaining.

COSPAR will consist of 15 members in all, with the U.S. and Soviet Union represented on its five-man executive committee. Other committee representatives will come from those nations having satellite and major rocketry programs, the nine International Scientific Unions concerned with space research, and from three nations participating in satellite tracking or other aspects of space science to be chosen on a rotational basis.

The parent ICSU, a world scientific group which sponsored the IGY, is comprised of 13 International Scientific Unions in various fields, and 43 national academies and similar bodies. The national scientific academies of Argentina and Bulgaria were accepted for membership at the 1958 meeting.

In the light of COSPAR, it is very probable that separate U.S. and Soviet proposals concerning the peaceful exploration of space presented to the UN will be dropped in favor of a new formulation for an international space agency by COSPAR.

Also supporting the ICSU scheme is the International Astronautical Federation, which is seeking to affiliate its space activities with ICSU. However, since the IAF charter prohibits its membership in ICSU, the Federation has under consideration the formation of three Divisions, one of which, the Division of Space Sciences, will qualify for membership in the world scientific organization.

NASA Sets Up Shop—A Month Ahead of Time

On Oct. 1, a month ahead of the statutory date, NASA commenced operations, officially absorbing NACA and taking over NACA headquarters in Washington. T. Keith Glennan, in announcing the moves, also noted that the three main NACA laboratories would be renamed, the Langley Aeronautical Laboratory becoming the Langley Research Center, Ames Aeronautical Laboratory the Ames Research Center, and Lewis Flight Propulsion Laboratory the Lewis Research Center. No name changes appeared to be in prospect for the field stations at Edwards Field, Wallops Island or Sandusky.

The 28 NACA committees and subcommittees are expected to be reconstituted as NASA advisory groups, at least until the end of this year.

Missile Market

(CONTINUED FROM PAGE 62)

pany also produces electronic components, such as the Vernistat potentiometer and the Spectracord ultraviolet spectrophotometer.

Rapid growth in P-E's business seems to be indicated for many years. In the vanguard of military IR development, the company's products include devices that guide, detect and track missiles, and record their paths. The company also produces lenses for satellite and meteor tracking cameras, as well as missile components.

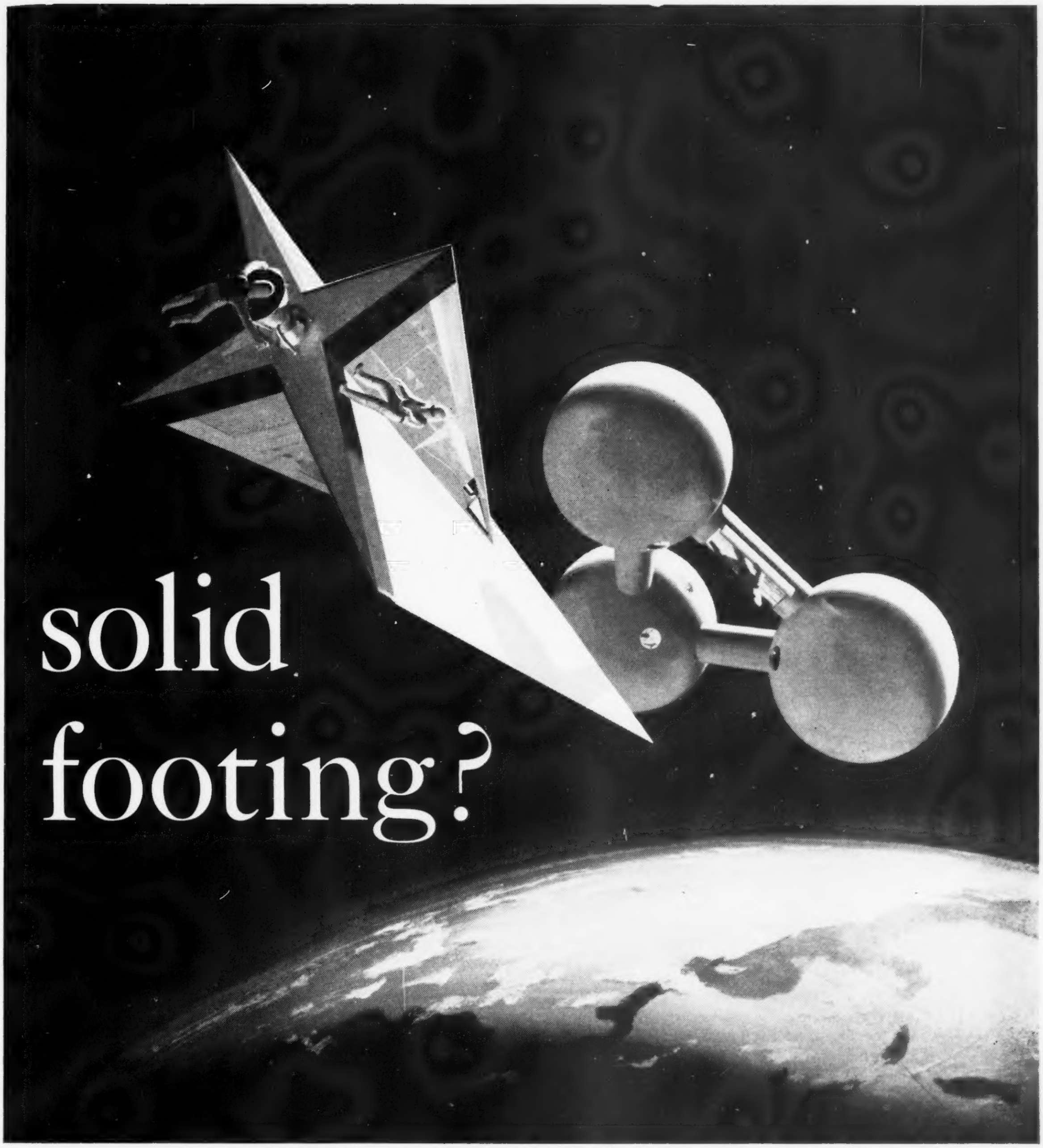
Looking at the figures, the last 10 years have seen Perkin-Elmer's sales multiply more than 12 times, from $1.2 million in fiscal 1948 (ending July 31) to $14.7 million in 1958. For fiscal 1959, sales could reach $18 million, an increase of 16%. During this same period, total earnings have exhibited almost the same kind of vigorous growth, despite high costs incurred in developing new products and markets. Earnings grew from $111,000 in 1948 to $680,000 in 1958, and $865,000 is estimated for fiscal 1959. Only in 1955, when the rain-swollen Norwalk River flooded the company's main plant to cause over $370,000 in nonrecurring expenses, was there a halt in year-to-year gains.

Growth is less pronounced on a per-share basis because the company has frequently offered new stock to finance expansion. In fiscal 1948, on the 210,000 shares then outstanding, Perkin-Elmer earned 53 cents. The fiscal year just completed should show per-share earnings of $1.35 on 520,000 shares. Next year's estimate is for earnings of $1.75 on the 555,000 shares currently outstanding. This is impressive growth in the face of heavy dilution. Perkin-Elmer pays out none of its earnings as dividends, preferring to plough it all back into the company's expansion.

Many R&D Programs

It is important to realize that Perkin-Elmer spends considerable amounts of its own money on R&D programs. For fiscal 1958, about $1.90 per share, which compares with reported earnings of $1.35, was spent in this fashion. This figure does not include R&D conducted under government contracts. In fiscal 1959, P-E could spend as much as $2.10 per share, of its own funds, on R&D. This is the foundation upon which the company's future growth will be built.

Across town from P-E is the headquarters of *Barnes Engineering Co.* During this past summer, millions of



To a man floating weightless around Space Station C, these are perhaps meaningless words—but *solid footing* is highly important to most of us who live and work on the surface of the earth.

Autonetics has established a solid footing in inertial guidance through 12 years of successful development and production of airborne and ocean-going systems, as well as systems for space applications.

The healthy growth of the Autonetics Guidance Engineering department—based on a number of highly diversified contracts—has created new senior-level positions in the fields of electro-mechanical component development and system analysis.

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newspaper readers were introduced to Barnes Engineering (and infrared generally) through front-page stories on "Operation Gaslight," including IR photographs of nose cone re-entry. A relatively new company, Barnes completed its third full year of operation on June 30. Although a smaller company than its Norwalk neighbor, Barnes is gearing itself entirely to the IR field, where the company has already established a strong reputation. Accordingly, Barnes recently sold some subsidiaries operating in non-IR fields. Studies are also underway to examine the possibility of enlarging the company's building to provide the space for expanded IR programs.

Headed by R. Bowling Barnes, the company is engaged in R&D projects and manufacturing operations in the following areas: Atlas, Thor and Polaris missile guidance and tracking; ICBM target study; instrumentation of earth satellites; optical and IR measurements of missile re-entry; and numerous projects for industry.

Sales Up 34 Per Cent

Sales for fiscal 1958 were $1.8 million, a 34 per cent increase over the previous year. Net profit per share, before nonrecurring income, but giving effect to previous year's tax credits, was 44 cents. Sales for the current fiscal year are estimated at between $2.5 and $3 million, while net per share is expected to improve just as handsomely. These estimates indicate a healthy growth for this young company.

The merger offer recently made to Barnes stockholders by General Transistor may also help the company's growth, for Barnes is planning to transistorize its equipment. General Transistor has offered one share of its stock for each $3^3/_4$ shares of Barnes Engineering. Barnes has 299,570 shares outstanding. If the merger goes through, present Barnes stockholders would own about 20 per cent of Transistor, whose appeal would be heightened considerably by this acquisition.

Guggenheim Fellowship Awards

Daniel and Florence Guggenheim Fellowships have been awarded to 15 students for 1958–59 graduate study in jet propulsion, rockets and flight structures at Princeton University, Cal Tech and Columbia University. The awards, made for outstanding technical ability, leadership and interest in the fields of graduate study offered, carry a stipend ranging from $1200 to $2000 annually plus tuition.

Space Flight

(CONTINUED FROM PAGE 48)

engine firings, proved beyond expectation the soundness of its advanced structural design and functioning during flight. This is unique in the history of development of rocket vehicles. Like every other rocket vehicle, the Atlas had its teething troubles and is likely to have more. However, it has proved that it can be counted upon as a weapon system and, beyond this, as a space vehicle booster, capable of carrying large payloads into terrestrial orbits, landing instruments on the moon, and opening the entire inner solar system to instrumented research and space exploration.

The Titan ICBM missile, whose implications for advanced space missions are similar to those of Atlas, is steadily moving toward its first test flight phase.

As the above would indicate, the astronautical potential of present hardware, shown in the chart on page 47, is encouraging.

Space Science

The principal space scientific discovery thus far this year is the finding of high intensity radiation at altitudes in excess of 1000 km (550 n.mi.), This discovery is of great importance to the geophysical sciences and to astronautics, especially manned space flight. Yet its greatest significance may be the indication that new and unexpected discoveries wait for us in the depths of space which we may fail to recognize from the surface and which require on-the-spot investigation either by instruments or by man himself. In our civilization, characterized by the crucial importance of science and technology for the independence and welfare of nations, it would be foolhardy to underestimate the potential of future discoveries in space.

Explorer IV, equipped with two small Geiger counters and two scintillation counters, essentially verified the results of Explorer I and III. Of the two Geiger counters, which measure the radiation intensity inside the satellite, one is not shielded with lead. The scintillation detectors, measuring the radiation intensity outside the satellite, are both shielded, except for windows of lesser shield thickness for detection of softer components. Thus a wide range of radiation intensities can be distinguished.

Radiation measurements have been received between 300 km (167 n.mi.) and 2200 km (1220 ni.mi.). Radiation intensity begins to rise rapidly at about 400 km (220 n.mi.). However, according to James Van Allen of Iowa State Univ., who is in charge of these

NOTABLE ACHIEVEMENTS AT JPL...

PIONEERS IN MOBILE MISSILE SYSTEMS

The "Sergeant's" excellent mobility characteristics, including the ability to operate under conditions of winter snow, ice, mud, desert sand and heat, significantly extend the capabilities of the system for close support of a ground command in our modern United States Army. The ease of operation and handling permits the weapon to be unloaded from airplanes or landing craft and be ready for firing with a minimum of preparation.

The system concept demonstrated in the "Sergeant" has permitted excellent mobility and speed of operation to be attained. The requirements of the Army have been stressed, resulting in outstanding characteristics of the weapon meriting the title of "America's first truly 'second generation' surface-to-surface tactical missile."

The responsibility for accomplishing this important achievement has been placed on JPL by the United States Army Ordnance Missile Command.

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measurements, no dangerous radiation level for prolonged stay of humans (at least weeks) has yet been found at altitudes around 300–350 n.mi. (540–630 km). Radiation intensity has been found to double every 100 km (56 n.mi.), with no sign of leveling off below 1600 km (890 n.mi.).

At these altitudes, which are around the 2-hr satellite orbital altitude, the radiation intensity reaches enormous proportions. The energy of hard components is of the order of 6 mev if the particles are electrons and 40 mev if they are protons. Dr. Van Allen and his co-workers find that at 1600 km the exposure level is of the order of 2 roentgens per hour. Compare this with the *maximum* crew dose rate, in vehicles involving nuclear radiation, of about 300 milli-roentgen per week, assuming continuous exposure, or about 1.8 mr/hr as *maximum* hourly dose. The exposure level at 1600 km altitude is of the order of a thousand times the maximum permissible hourly dose for humans. Thus an unshielded human at this altitude would meet death from radiation within about two days if the hard components are electrons, or within a few hours if they are protons.

These numbers do not look favorable for space stations orbiting at the 2-hr period or higher (by a yet undetermined distance). Nevertheless, space stations appear possible at lower altitudes.

Of interest in this connection is the dynamics of the radiation belt. Little is known as yet in this respect, and years may be required to obtain the complete picture. It has been found that the flux of high energy particles decreases from the magnetic equator to higher latitudes. Symmetry about the eccentric magnetic dipole seems to exist, but the radiation intensity appears to be not equal along magnetic field lines. As far as precession of the orbit of Explorer IV goes, the radiation intensity increases equally with altitude at all latitudes covered by the satellite. The variation of radiation intensity with time, if it exists, must have been less than by a factor of two during the observation period, since a variation of this magnitude would have been detected by the counters. The present altitude of the upper radiation limit and the variation of upper and lower limit with time or with sunspot activity is as yet unknown.

Density Measurements

Another important area of research with satellites pertained to atmospheric density measurements. These data, mainly based on Sputnik observations (1957 α and β) indicate a considerably higher density than expected—as much as eight times the density of the ARDC atmosphere between 200 and 275 km. This high apparent density, derived from drag data, may be due in part to electromagnetic drag caused by ionized particles, rather than by gas dynamic drag. Although important for practical lifetime computations of satellites, this information may not reflect the correct atmospheric density. Comparative data from high altitude rockets are therefore needed.

Micrometeorite measurements showed a fairly high number of hits involving very small particles. Measurements based primarily on the wire-gauge data of Explorer I indicated tentatively an impact rate of not more than about one per ft^2 in 3000 sec for particles of 10 microns or more in diam and about 10 times this rate for particles of 4 microns or more. These results are yet uncertain. In general, they seem to verify Fred Whipple's latest pre-Sputnik estimates, presented during last year's International Astronautical Congress in Barcelona.

It requires time and patience to thoroughly evaluate the results of satellite measurements. In view of

this and of the rapid sequence of planned satellite flights, the next few years can be expected to add an enormous amount of new geophysical, radiation-physical and astrophysical information, and to expand greatly the knowledge of our immediate cosmic environment.

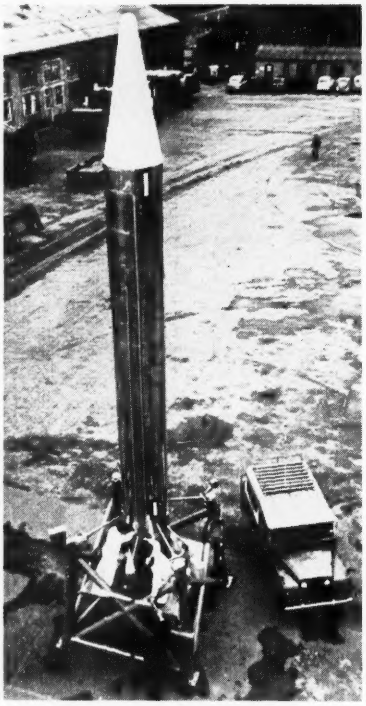
During the last IGY Conference in Moscow, a recommendation was accepted to extend the IG "Y" informally for another year. It is hoped that this may be the beginning of permanent international teamwork in the exploration of the solar system, as proposed by this author at the IAF Congress two years ago. Herein lies one of the noblest contributions of space flight to easing tensions of our time. However, to be able to contribute effectively to the establishment of peaceful space exploration, this country's space capability must be second to none. We can expect to see greatly stepped-up activity in the field of manned hypersonic flight and orbiting. Getting a man into a temporary satellite orbit *soon* is of paramount significance in the development of manned space flight. By solving this problem, a great many problems connected with manned circumlunar reconnaissance flights are solved likewise. Manned circumlunar flights, however, are the first step toward the exploration of the lunar surface by man.

More Probes Coming

In the geophysical and selenophysical area, the exploration of cislunar and lunar space by instrumented probes will continue. Important areas of research are extension of the high intensity radiation region and variation in micrometeoritic density, magnetic and electric fields. Specifically pertaining to the moon, detailed surface reconnaissance from lunar satellites with high resolution (down to a few feet) is important as a preparation to landing an instrument package. Astrophysically and geophysically, photosatellites are urgently needed to begin a systematic optical surveillance of the earth's cloud coverage and albedo, and to initiate a new branch of astronomy, namely, what might be termed UV-astronomy, the observation of the sun and the stellar sky in the light of excited hydrogen and helium.

The exploration of interplanetary space should not be put off as a matter for the more distant future. With Atlas getting ready for full-range flights, the necessary basic hardware for conducting exploratory flights into the inner solar system with a scientifically adequate payload is becomming available. It must be kept in mind that the possibilities for carrying out interplanetary flights are limited severely by the relative rareness of suitable planetary constellations. With this year's chance gone for launching a Mars probe (a good opportunity existed this July–August) there are only four opportunities left within the next 10 years. Beginning with June, 1959, there exists six opportunities for launching a Venus probe during the next 10 years. Since such flights require a bigger vehicle and still more elaborate preparations than present earth satellites or even moon probes, it is not too early to begin the planning and preparation of interplanetary flights now.

UK and Australia Test Missiles, Plan for Space



Great Britain's Black Knight re-entry test vehicle, which reached an altitude of some 300 miles in Sept. 7 launching.

This summer, Australians saw the most extensive display yet of rocketry in their country, and heard plans for further developing the Woomera missile testing range and for giving Great Britain representation in the space age.

The rocket show at Australia's Weapons Research Establishment (WRE) at Salisbury displayed both well-known missiles developed in England during the past decade such as the Thunderbird and Bloodhound ground-to-air missiles, the air-to-air Firestreak, the ship-to-air Seaslug, etc., as well as current research vehicles, such as the Zulu Squire, the Australian-developed Skylark and Long Tom sounding rockets, and Britain's re-entry test vehicle, the Black Knight, launched successfully Sept. 7 at Woomera. The Australian anti-tank missile Malkara, which is something like the American Dart but weighs 200 lb, was also shown and demonstrated. Britain has ordered 150 Malkaras for further testing.

News attending the summer display of missiles was that the British IRBM Blue Streak, a liquid propellant missile of some 200,000 lb thrust and 2500-mile range, will be field-tested at Woomera on completion of static-firing trials now going on in England. Woomera is being expanded to the northwest to the maximum land range of 1100 miles, and a launching site is being built at Lake Hart, 30 miles west of Woomera, to accommodate the launching of Blue Streak and other large rockets.

Great Britain's immediate plans for space experiments include the use of the Black Knight as a re-entry vehicle and sounding rocket; the sending of animals aloft in both the Black Knight and Blue Streak; and the possible use of Blue Streak to launch satellites. According to Aubrey Jones, British Minister of Supply, who made his first Australian visit during the rocket and missile fete, the Royal Society is studying the scientific value of satellites in relation to the needs of Britain's missile program.

—**A. R. Shalders**

New Wind Tunnel

A new \$1.2 million transonic-supersonic wind tunnel, which can set up wind velocities from 600 to 1000 mph, has been unveiled at Republic Aviation Corp. The 6000-sq ft facility with a range up to Mach 4, will be used to create and evaluate tests on the F-105 jet fighter-bomber, as well as missile designs.

Snow on Saturn

University of Chicago astronomer Gerard Kuiper reports that the rings of Saturn are made of snow. He has also detected snow on two of Jupiter's nine known moons.

Kuiper made his discoveries at the Yerkes Observatory, using an infra-red spectrometer that he developed almost a dozen years ago.

From the patent office

By George F. McLaughlin

Analog Computers Solve Air-Speed Equations

True air speed of an aircraft or missile may be measured directly by methods independent of atmospheric pressure, temperature and Mach number. The invention compares the direction of air flow around a detector with its rotational speed to give a measure of true air speed.

It employs electromechanical analog computers which solve the air speed equations used in restoring correct triangular relationship in the system.

The diagrams on this page illustrate the system, and quantities measured. The detector is mounted for rotation in a plane perpendicular to the direction of travel of the vehicle.

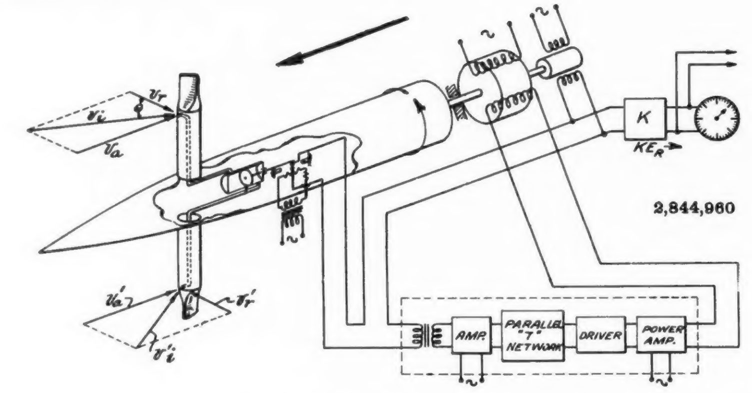
For all vehicle speeds, when the detector maintains the angle fixed by adjustment in the magnitude of vector V_r, a correlation exists between the vehicle velocity and the detector rotational speed. From this relationship, the magnitude of vector V_a can be determined. Determination of the magnitude of the vehicle air-speed vector V_a depends upon preserving of the correct triangular relation between the air speed vector components.

A streamlined member mounted in the free air stream, carries a pressure-responsive air-flow-direction detector comprising a pair of tubes extending in opposite directions radially from the axis of rotation of the member. Near the outer end of each tube (at equal distances from the axis of rotation) orifices connect through conduits to opposite sides of a differential-pressure piston.

When pressures are unequal, the piston will move in a direction determined by the difference in pressure at the orifices, thereby actuating a potentiometer. This signal has a polarity dependent upon the direction of piston movement and a magnitude dependent upon the extent of movement.

The potentiometer winding is energized through a transformer from a source of electrical energy, such as a constant-peak-amplitude alternating current and wiper connected to be displaced by the piston. Movement of the wiper produces a signal on leads which is dependent upon (and varies in proportion to) change in direction of the resultant air speed vector V_i relative to the plane of rotation of the detector, as detected by the orifices.

Orientation of the orifices relative to the plane of rotation of the detector is fixed at some predetermined angle.



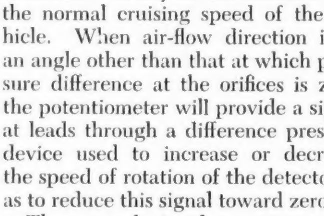
Schematic perspective of the system for indicating true air speed of an aerial vehicle.

Angular orientation of the detector is selected from a design standpoint as a function of an optimum, practical, rotational velocity of the member and the normal cruising speed of the vehicle. When air-flow direction is at an angle other than that at which pressure difference at the orifices is zero, the potentiometer will provide a signal at leads through a difference pressure device used to increase or decrease the speed of rotation of the detector so as to reduce this signal toward zero.

The control signal source may be arranged to supply a signal varying linearly with changes in the direction of air flow from a position at which the pressure at the orifice is a maximum.

Through conventional means, the two phases of the motor member rotating are excited substantially 90 deg out of phase electrically. Attached to the motor drive shaft is a generator having an output proportional to the rotational velocity of the member and, therefore, of the detector.

Generator output (together with the output of the signal source including the pick-off) controls the speed of the drive motor through a servo amplifier. The error signal from the pick-off is supplied as an input signal to a preamplifier through a coupling transformer. The output of the preamplifier is applied to a parallel T network, the output being a voltage proportional to the original input signal and the rate of change which is applied to a power amplifier stage through a driver network. The output of servo amplifier is supplied to the control winding of the drive motor.



Relationship between air-speed vector components effective at any instant on an air flow direction detector, as it advances through the air at constant pitch helix.

The motor is speeded up (or retarded) according to the magnitude of the error signal at the potentiometer. At zero differential pressure, the direction of the resultant air speed component V_i will coincide with that shown in the diagram at the bottom of the page.

In operation of the device, when the vehicle increases its forward speed, the magnitude of vector ${}_r$ increases by an amount necessary to maintain the direction of vector V_i at the predetermined angle θ relative to the plane of rotation of the detector. Since a relation exists between the rotational speed of the detector and its angular (constant) position, the magnitude of the output signal is proportional to the air speed of the vehicle.

The generator signal may be used to actuate an air-speed indicator, or to supply, through electrical leads, a signal proportional to the air speed of the vehicle to other equipment in the vehicle, or to ground stations.

Patent No. 2,844,960. Air-Speed Measuring Device. Basil Staros, (ARS member), Massapequa, N.Y., assignor to Sperry Rand Corp.

A Year of Growth for ARS

(CONTINUED FROM PAGE 45)

Meanwhile, ASTRONAUTICS, in the little more than a year of its existence, has established itself as the leading scientific publication of the rocket and space flight fields, and has already garnered a number of major honors for both its editorial content and format. ASTRONAUTICS can also be expected to grow as the Society grows.

The rapid expansion of interest in rocketry and astronautics has also faced the Society with a number of new problems. Our Technical Committee setup, for example, established only two years ago, is already outmoded and, as a result of a careful study by the Policy Committee, is being completely revamped. Full details of the new Technical Committee setup will be announced at the Annual Meeting.

Expansion of member services has also resulted in expansion of the headquarters staff and the subsequent need for additional space. It is hoped that, sometime within the next few years, the Society will have a permanent home befitting its important position in the new Space Age.

The past year has also seen a good deal of work on several special ARS projects. Of these, the proposed Goddard Memorial is outstanding, and it is hoped that, by the end of next year, a suitable memorial to this country's great rocket pioneer will have been erected, either on or near the spot where Dr. Robert H. Goddard successfully fired the world's first liquid rocket.

Along with ARS growth has come the need for establishment of standard operating procedures for the organization of Sections and for national and local meetings. The past year has seen the publication and dissemination of special guides for these purposes.

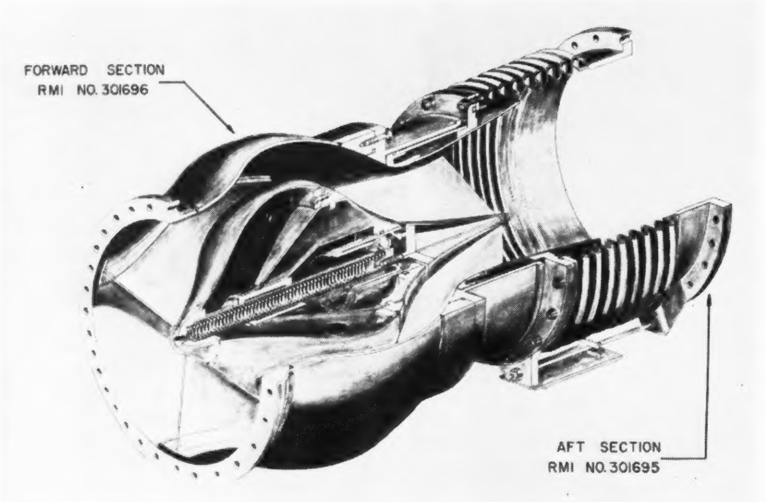
Since the youngsters now attending high schools and colleges throughout the country will form the backbone of the ARS of tomorrow, it is only natural that considerable emphasis has been and is being placed on the Society's student activities. This is reflected in the formation of several new Student Chapters, in the Student Conferences at our Annual and Semi-Annual Meetings, and in the leading roles played by ARS Sections in youth educational programs in many areas.

I would like to take this opportunity to offer my sincere thanks to our board members, our committee members, our headquarters staff, the officers and directors of our 42 Sections and 12 Student Chapters, the speakers at our national, regional and local meetings, and the many, many others who have made valuable contributions to our technical programs, our meetings and our publications.

Without their assistance, the phenomenal growth and membership acceptance the Society has realized in the past year would not have been possible. And, certainly, the interest and support of our corporate members, advertisers and the press should also not go unnoticed.

On pages 24 to 28 you will find full-scale reports by the ARS Technical Division Chairmen on important developments in their fields during the past year. These reports all indicate a bright future for the entire rocket and space flight industry.

The same holds true of ARS as well. It has been my pleasure to serve as ARS President during this most exciting year. As I prepare to leave office, I am heartened by the fact that 1958 has not been the culmination of all that the Society has worked for down through the years, but rather the beginning of a new and exciting era which will make all that has gone before it pale by comparison.



A Really Big One

Looking something like a rocket motor itself, this quick-disconnect check valve, designed by Thiokol's RMI Div., handles lox flow rates up to 6500 gal/min at 70 psi, with pressure drop of only 4 psi through its $3^1/_2$-ft length. Such large valves can serve to cut the flow of propellants to separable boosters, like the pair on Atlas.

Liquid Rockets

(CONTINUED FROM PAGE 51)

for continuous throttling which can be provided only by a liquid rocket.

In manned space vehicles, it will be necessary to provide a fail-safe system—that is, a system which will insure that, even in the event of failure, the space men will not be injured and will return to earth safely. Experience to date indicates that the liquid rocket can be equipped with fail-safe devices, and rockets of this type have already been demonstrated as JATO units and in research aircraft like the X-1 and X-2.

The liquid rocket has one other major advantage: It can operate at extremely low chamber pressures. This provides a number of advantages in space flight. High performance can be obtained with reduced inert weights, reduced pressurization-gas requirements, smaller gas generator needs and long-duration operation because of greatly reduced heat-transfer rates to chamber and nozzle walls. Combustion studies have indicated that a chamber pressure of 5 psia is feasible, with resulting high performance and low heat-transfer rates.

Low chamber pressure also permits the use of a simple gas pressurization system instead of a turbopump system. In the case of some propellants, vapor pressure can be used, with the addition of heat, to supply the needed pressurizing gases.

The potentialities of the prepackaged, low chamber pressure liquid rocket are enormous, particularly for the upper stages of a space vehicle. To the best of the author's knowledge, this area of low chamber pressure operation has not as yet received sufficient attention. However, because of the tremendous importance of a rocket of this type in space flight, this represents one field in which an intensive development effort is required.

Has Many Uses

In addition to upper-stage applications, a rocket with low chamber pressure and small thrust, capable of continuous throttling, could be used for space navigation, maneuvering of cargo in a space station, and a number of other tasks.

Furthermore, liquid propellant thrust chambers can be clustered to obtain larger thrust, if desired. In fact, preliminary investigations have shown that it is advantageous to cluster on the basis of overall weight and reliability. There is no apparent limit on the size of a liquid rocket in terms of thrust and total impulse.

It is interesting to note in this regard that the recent award of a contract for development of a 1.5 million-lb thrust liquid rocket calls for clustering of booster motors proved in the Jupiter, Thor and Atlas missiles (see page 50), and that this technique was selected because it represented the quickest and least costly way of obtaining an engine of the desired size.

The need for even larger engines, in the 5- to 10 million-lb thrust class, has already been indicated, and it is not at all unreasonable to assume that, when such units are built, they too will be liquid rockets.

In considering liquid rockets, one should also mention the matter of reliability. A great deal has been made of the fact that, by virtue of system complexities, the liquid rocket is not as reliable as it might be. While it is true that in the past some liquid rockets have not been as reliable as we would have liked, this is not to say that a particular rocket cannot be made reliable when sufficient numbers of it have been built and tested. Great strides have been made in this area, but it must be kept in mind that reliability can be achieved only through intensive testing in both the development and production phases.

Extrapolating from the present state of the art, then, it would appear that liquid rockets are not only here to stay, but, with the growing call for space propulsion systems, will become even more important in the foreseeable future.

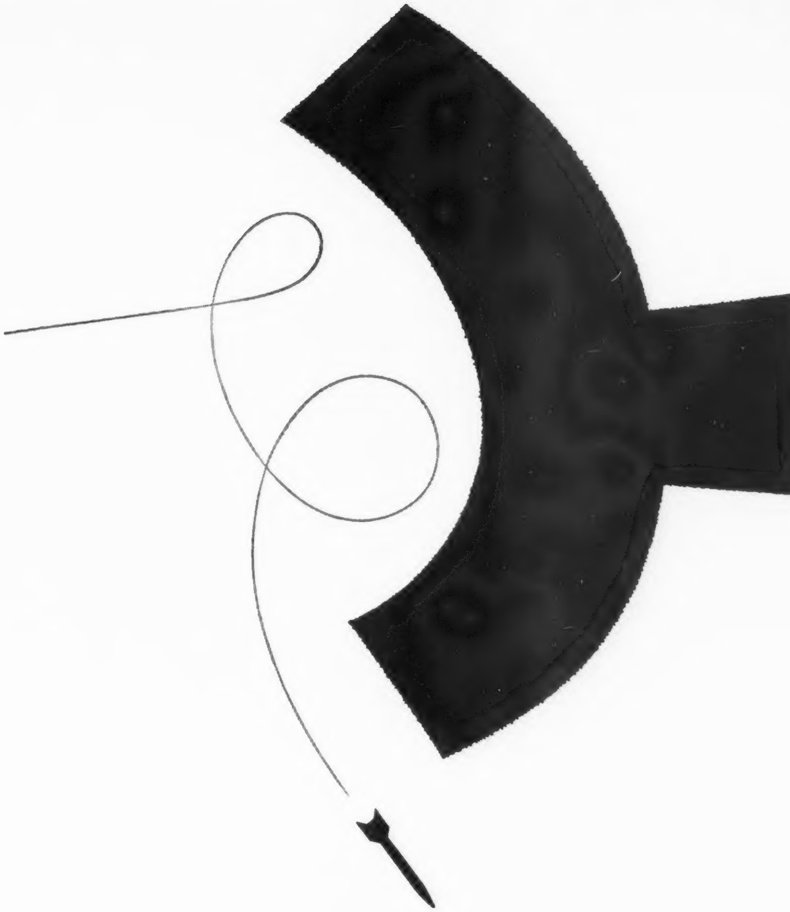
More Perchlorates Due

HEF, Inc., a recently formed joint subsidiary of Hooker Chemical Corp., Niagara Falls, N.Y., and Foote Mineral Co., Philadelphia, has begun construction of a plant for producing several million pounds of ammonium perchlorate per year. The plant will also be able to produce lithium perchlorate. Hooker, largest manufacturer of sodium chlorate, the basic raw material for perchlorates, is also planning to spend $1 million in its third major expansion of sodium perchlorate production capacity.

These moves possibly anticipate the supplanting of ammonium nitrate in composite propellants by the higher energy perchlorate and use of metal perchlorates in coming sophisticated solids.

Correction

The shock tube photo on page 20 of the article on magnetohydrodynamics in the October ASTRONAUTICS was inadvertently captioned incorrectly. Gas flow in the tube was from bottom to top, not from left to right, as the caption stated.



Instrumentation

(CONTINUED FROM PAGE 55)

sensing discrimination must, then, be orders of magnitude finer than those used today. This will be not much easier to do than the weighing of particles. It is improbable that present techniques can be extrapolated to attain such improvement. It is appalling to consider that, even after such a device has been designed and built, it will be next to impossible to test it prior to flight. Perhaps it would be more correct to say that the testing and calibration will require as much ingenuity as the design of the device. A laboratory in space, or at least in terrestrial orbit, may prove to be the answer.

Gyro Development

Since today's furthest developed accelerometers are of the gyroscopic type, it is natural to associate this imposing inertial problem with developments that we hope to see in gyroscopes (with spinning wheels). Operating life of such devices must be drastically increased for missile standby requirements as well as for protracted space use. One approach may be the replacement of ball bearings on spin axes with dynamic air bearings with infinite life. Accuracy of inputs and outputs may be increased by pulse-torquing and digital readouts. Such improvements will all be in the right direction but far from the needed magnitude for the interplanetary case. It is the sensing capability itself that must be vastly increased and that may require that the prosaic spinning wheel gyroscope move over to be replaced by a "geescope" or "inertiascope" using other inertial sources or force-sensing means. These may involve motion of electrons or atomic particles.

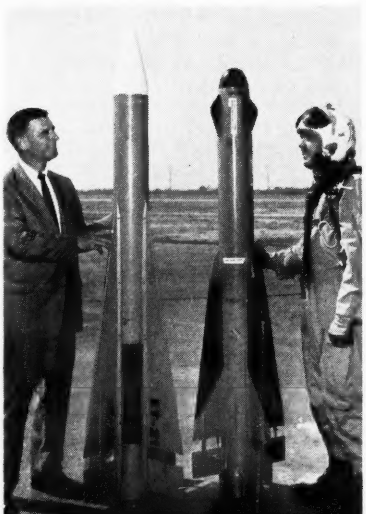
The coming year will see further development of the gimbal-less inertial guidance system, in which the sensing devices are vehicle-fixed and computing elements replace the stable platform. Use of digital techniques is essential to the success of this arrangement. Although of great promise, it does not obviate the need for super advances in the inertial elements for interplanetary sailing.

Despite the proven capability of all-inertial guidance systems for our first generation long-range missiles, it is probable that there will be requirements in the next few years for hybrid systems that combine with inertial memory the corrective possibilities of radio, celestial observation, Doppler radar, mapmatching, etc. Study of the use of infrared techniques, which have had too little accent for applications other than air-to-air weapons, should get a good fiscal shot in the arm for long-range midcourse and terminal guidance, as well as in space—nearby and way out there. The relation between infrared and photographic techniques will prove of great import.

The application of digital techniques to the computer field has been amazingly rapid considering that, only a few years back, it was the subject of basic development work. The emphasis has been pretty much on the higher inherent accuracies, which may be limited only by the circuit complexity that can be tolerated. The future must see drastic improvements in reliability in digital components and systems to ensure their successful use in space systems. It will be of small comfort to our passengers on the Venus Express to know that they are becoming points on a learning curve or specks on a statistical dot chart.

Guidance, instrumentation and control technology will advance on the same exponential curve that is already in the books. That is for sure. The change in ball parks that we're about to experience will be of much greater significance than what has happened to the Dodgers, and one thing is certain: We can't afford to end up in the second division.

Falcon GAR-3 Bows



Powered by a new solid propellant rocket motor and tipped with a ceramic nose cone, the radar-guided GAR-3, latest in the Falcon series, has the longest range of any U.S. air-to-air missile, according to Hughes officials.

Government contract awards

Ryan to Make Army Navigation System

Ryan Aeronautical Co. has received a letter of intent from the Army Signal Supply Agency authorizing approximately $1 million production of an integrated automatic navigation and flight-control system (RAV Model 120A). This electronic navigating system employs continuous-wave Doppler radar.

Hydraulic and Pneumatic Systems for Space Vehicles

Lockheed Aircraft's Georgia Div. will study power-operated hydraulic and pneumatic systems for space vehicles under AF contract and in conjunction with WADC's Aircraft Lab. This Lockheed group is also working under an ARDC contract to design and develop a 5000-psi pneumatic system for operation at 1000 F.

M-H to Study Controls For Jet Aircraft

Minneapolis-Honeywell Regulator will study how pilots use flight data and what kind of controls in what position are best suited for directing supersonic aircraft under a $75,000 contract with Douglas Aircraft, prime contractor with ONR for Army-Navy instrumentation program.

Solids Studied as APU For Nike-Zeus Missiles

Garrett Corp.'s AiResearch Mfg. Div. has been contracted by Douglas to develop a solid-propellant gas generator for an auxiliary turbo-generator in Nike-Zeus.

Silver-Zinc Torpedo Batteries

Navy BuOrd has awarded Yardley Electric Co. a $394,800 contract for production of its Silvercel batteries for use in torpedoes such as the homing torpedo of RAT.

Radar for Cloud Tracing

Siegler Corp's Olympic Radio and Television Div. has been awarded a $350,000 AF contract to design and develop ground-based radar (AN/TPQ-11), operating in a 35,000 mc range, to provide a continuous map of the height and density of cloud layers over the radar site.

Atlas Ground-Handling System

Goodyear Aircraft has awarded Sancor Corp. a $100,000 contract to design and manufacture a complete hydraulic system to transport, handle and erect Atlas.

Valves for Titan

The Martin Co. awarded one contract for developing and producing Titan propellant-system valves to the Clary Corp., with deliveries to begin this fall, and another to Koehler Aircraft Products Co. for production of a series of lox valves for the Titan program.

Lox-Tanking Computers

Hayes Aircraft Co. has awarded Servomechanisms, Inc., a $228,291 contract for production of dual-mode lox-tanking computers.

Reaction Catapult for Enterprise

Thiokol's Reaction Motors Div. has received a BuAer letter contract for production of four internal-combustion catapults for the first nuclear-powered carrier, the USS Enterprise. The catapult system has been under development at RM since 1948.

Kodak Contracts

Eastman Kodak will produce a TV-optical head for B-52 fire-control systems, a fuze for Sidewinder, and an arm-safe mechanism for Hawk under continued contracts, and a TV-optical bombsight for the Navy's new A3J attack aircraft under a new contract. Contracts total $3 million.

Missile Monitor Production

Hughes Aircraft has received a $30.7 million Army Signal Corps contract for production of parts of the Missile Monitor (AN/MSQ-18), a battalion-level overall control center for an Army in the field which links radar with missile installations, such as Nike and Hawk.

Proximity Fuze for Bomarc

Bendix Aviation's York Div. will develop and produce a proximity fuze for the IM-99B Bomarc under a $1,750,000 contract.

Countermeasures Tester for Hustler

Under subcontract with Sylvania Electric, ITT's Farnsworth Electronics Div. will design and develop "go-no-go" equipment to test operation of the B-58 Hustler's countermeasures system.

Thor, Nike Test Equipment

Electro Instruments, Inc., will make $250,000 worth of digital test equipment for Thor under contract with A.C. Spark Plug, and $160,000 worth of digital measuring instruments for Nike installations under contract with Frankford Arsenal.

Solid-State Physics Research

Servomechanisms, Inc., has received $101,672 from Douglas Aircraft for further research in solid-state physics, with emphasis on high temperature materials.

Beryllium Ductile Castings

The Air Force, through AMC, Wright-Patterson Field, has issued a contract to the Beryllium Corp. for the development of a commercially practical method of producing ductile castings of beryllium metal. Commercial-grade beryllium is presently formed through a lengthy and costly reduction to powder and then consolidation by heat and pressure in a furnace.

Test and Evaluation Instruments for Polaris

The Navy awarded Interstate Electronics Corp. some $1 million for Polaris ground-testing instrumentation to be installed at Canaveral and nearly $2 million for instrumentation to be carried aboard submarines during test firing of the missile.

SYNOPSIS OF AWARDS

The following synopsis of government contracts awards lists formally advertised and negotiated unclassified contracts in excess of $25,000 for each Air Force, Army and Navy contracting office:

AIR FORCE

AF Cambridge Research Center, ARDC, USAF, Laurence G. Hanscom Field, Bedford, Mass.

Research and development on accurate methods for tracking and communicating with space vehicles, $50,600, **Pickard and Burns, Inc.**, 240 Highland Ave., Needham, Mass.

AF Flight Test Center, ARDC, Edwards AFB, Calif.

Valves for propellant fuels, $27,937, **The Annin Co.**, Division of Annin Corp., 1040 S. Vail Ave., Montebello, Calif.

Aviation Supply Office, 700 Robbins Ave., Philadelphia 11, Pa.

Spare parts for target drones, $161,661, **Ryan Aeronautical Co.**, 2750 W. Lomita Blvd., Torrance, Calif.

HQ, AF Office of Scientific Research, ARDC, Washington 25, D.C.

Continuation of research on combustion ignition, $40,665, **Arthur D. Little, Inc.**, Cambridge 42, Mass.

Continuation of exploratory research on burning propellants in rocket engines, $115,734, **Bell Aircraft Corp.**, Buffalo 5, N.Y.

Research on paramagnetic resonance of free radicals, $131,724, **Washington Univ.**, St. Louis, Mo.

Continuation of theoretical and experimental investigations in high speed aerodynamics, $64,816, **Cornell Univ.**, Ithaca, N.Y.

Continuation of analytical and experimental study of the effect of aerodynamic heating on aircraft structure, $101,500, **Stanford Univ.**, Stanford, Calif.

Continuation of research on stability and transition of the laminar boundary layer, $139,000, **North American Aviation**, Downey, Calif.

Research on radiation in rocket motors, $66,511, **Aircraft Gas Turbine Div.**, General Electric Co., Cincinnati 15, Ohio.

Research on transonic and supersonic flow, $61,348, **Brown Univ.**, Providence, R.I.

Patrick AFB, ARDC, USAF, Patrick AFB, Fla.

Rocket propellant, $37,240, **Westvaco Chlor-Alkali Div.** of Food Machinery and Chemical Corp., 161 E. 42 St., New York 17, N.Y.

ARMY

Boston Ordnance Dist., Army Base, Boston 10, Mass.

Repair parts, Hawk missile, $2,085,530, **Raytheon Mfg. Co.**, Andover, Mass.

District Engineer, U.S. Army Engineer Dist., P.O. Box 1538, Albuquerque, N.Mex.

Satellite tracking station, White Sands Missile Range, $82,476, **C. H. Leavell & Co.**, 1900 Wyoming St., El Paso, Tex.

Picatinny Arsenal, Dover, N.J.

Design, furnish and install telemetry ground and data recording station at Picatinny Arsenal, Dover, N.J., $150,131, **Applied Science Corp. of Princeton**, P.O. Box 44, Princeton, N.J.

New York Ordnance Dist., 770 Broadway, New York 3, N.Y.

Production engineering services for the preparation of miscellaneous ordnance documentation for the Nike-Hercules guided missile systems, $2,200,000, **Western Electric Co., Inc.**, 120 Broadway, New York 5, N.Y.

Purchasing and Contracting Div., White Sands Missile Range, N.Mex.

Balloons, $103,200, **Raven Industries Inc.**, Sioux Falls, S. Dak.

San Francisco Ordnance Dist., 1515 Clay St., P.O. Box 1829, Oakland 12, Calif.

Feasibility study for target missile system, $64,954, **Lockheed Aircraft Corp.**, Lockheed Missile Systems Div., Sunnyvale, Calif.

U.S. Army Ordnance Dist., Philadelphia, 128 N. Broad St., Philadelphia 2, Pa.

Nike spare parts and components, $3,342,402, **Western Electric Co., Inc.**, 120 Broadway, New York 5, N.Y.

Blue streak and emergency spare parts, $65,193, **Douglas Aircraft**, 3000 Ocean Park Blvd., Santa Monica, Calif.

Basic research entitled low energy nuclear and electron physics, $27,243, **Univ. of Pittsburgh**, Pittsburgh 13, Pa.

540 man-months of installation, repairing, modifying and developing electronic and related equipment for guided missile program, $411,944, **RCA Service Co.**, A Div. of Radio Corp. of America, Cherry Hill, Delaware Township, Camden 8, N.J.

Development, design and construction of lunar flight models, $49,652, **Spitz Laboratories, Inc.**, Yorklyn, Dela.

U.S. Army Ordnance Dist., Los Angeles, 55 S. Grand Ave., Pasadena, Calif.

Blue streak and emergency repair parts for Nike system, $365,042, **Douglas Aircraft**, 3000 Ocean Park Blvd., Santa Monica, Calif.

Development of devices to produce nuclear environments, $142,117, **Hughes Tool Co.**, Culver City, Calif.

Rocket engines, $50,000, **North American Aviation**, 6633 Canoga Ave., Canoga Park, Calif.

Emergency and blue streak spare parts for Corporal missile system, $124,048, **Gilfillan Bros., Inc.**, 1815 Venice Blvd., Los Angeles 6, Calif.

Repair parts for Corporal missile, $163,031, **Firestone Tire & Rubber Co.**, 2525 Firestone Blvd., Los Angeles 54, Calif.

Engineering research and development regarding missiles, free rockets, materials and wind tunnel operation, $352,800, **Cal Tech**, 1201 E. California St., Pasadena, Calif.

Rocket engines, $63,000, **North American Aviation**, 6633 Canoga Ave., Canoga Park, Calif.

Procurement of emergency and blue streak repair parts for guided missile artillery M2 and related ground handling and launching equipment, $72,998, **Firestone Tire & Rubber Co.**, 2525 Firestone Blvd., Los Angeles, Calif.

U.S. Army Ordnance Missile Command, Redstone Arsenal, Ala.

Research, development, manufacture, loading and delivery of XM45, modified XM20 and TX-76 igniters, $343,128, **Thiokol Chemical Corp.**, Trenton, N.J.

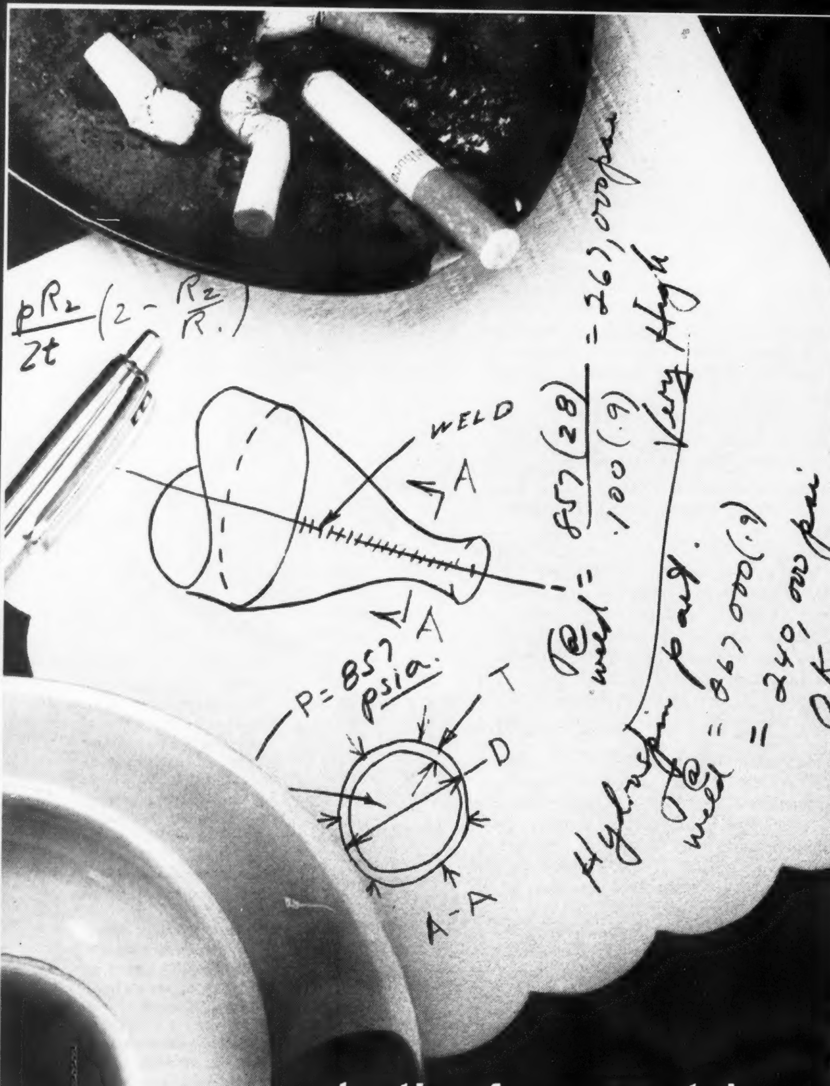
NAVY

Office of Naval Research, Washington 25, D.C.

Symposium on ecological problems related to confinement in the true submersible or sealed space cabin, $30,000, **American Institute of Biological Sciences**, Washington, D.C.

Research on a stratolab cabin system, $85,379, **Vitro Labs**, Div. of Vitro Corp. of America, Silver Spring, Md.

Study to determine feasibility and design of a wind tunnel to hypersonic, high enthalpy, low density gas flows, $35,000, **Polytechnic Institute of Brooklyn**, Brooklyn, N.Y.



Ramjets

(CONTINUED FROM PAGE 61)

This missile is currently continuing flight testing under a new program, Project Rise. As a result of its high flight speeds (Mach 3 and above) and high altitude capability (70,000 to 75,000 ft), data in flight can readily be obtained to answer many questions for assisting and accelerating the design of the new B-70 bomber. The ramjet engines are doing a job no other engine could possibly accomplish at this time. To make this program possible, Wright Aeronautical has undertaken an accelerated program to provide more engines with higher thrust and lower specific fuel consumption. This new program has provided, in only 5 months time, a new engine model fully tested and qualified for the flight program.

Piloted ramjet propulsion is no longer uniquely a LeDuc (France) activity. The availability of small lightweight turbojet engines has enabled the French Griffon II, shown on page 61, as well as the LeDuc 022 to demonstrate supersonic ramjet top speeds in a mixed powered aircraft capable of taking off and landing conventionally, i.e., without booster rockets and special recovery means. Both aircraft, while primarily of research interest, have demonstrated considerable capability, and the principle of mixed turbojet and ramjet propulsion appears destined for further exploitation.

In addition to recent releases relating to the progress of ramjet engines developed in Western Europe, there is news concerning Russian ramjet progress. On Jan. 25, 1940, the first flight test of a Russian ramjet was conducted in the Frunze Airfield in Moscow; two 16-in. diam subsonic engines were suspended from a Soviet I-15 fiighter and test-fired. The Soviet subsonic flight-test program continued through the 1940's using other piloted aircraft as test beds. Current Russian technical publications in the fields of combustion, aerodynamics and control systems, which are applicable to supersonic ramjet propulsion, indicate a high degree of technical "state of the art" in Russia today.

Nuclear-powered ramjets continue to appear very attractive, and the U.S. Air Force has anounced the assignment of a contract to Marquardt to participate in such a development. Obviously, reactor technology as enhanced by continuing AEC activity will exert considerable influence on current and future appraisals of nuclear ramjets.

Advances in the state of the ramjet art beyond the first 25 years include substantial combustion development work on nonhydrocarbon fuels selected

for superior burning limits, (i.e., high altitude capability) and higher heat release (better specific fuel consumption, thus improved range). NASA has reported experimental missile operation by means of ramjet burning boron compounds. This promises increased interest in ramjet application to long-range vehicles.

The demand for higher speeds and the confidence resulting from recent advances in high temperature materials and cooling techniques have contributed to more intense investigation of ramjet performance potential at speeds above Mach 4. The NACA 1957 Annual Report states, "The ramjet is capable of use to speeds of at least seven times that of sound and for special applications can be used for even higher speeds."

With the removal of the Mach 4 barrier for ramjets, a new application, "boost devices," is receiving considerable attention. The high thrust-weight ratio, the low cost in dollars per impulse second, and high reliability associated with ramjets are very attractive when considered in relation to missile, satellite and space-station boosters. A comparison of the booster and sustainer rocket performance with the ramjet performance in Dr. Avery's article indicates a significant reduction in fuel load required for a ramjet "boost" device. Reduction in the fuel load for boost applications provides large weight savings and increased payloads.

Now, in the twenty-eighth year of ramjet development, whole new areas of application, beyond the 1955 state of the art, are feasible. These are characterized by significantly higher potential speeds, advances in ramjet nuclear propulsion and the proved reliability of lightweight high powered ramjet engines. The latter should find application to piloted aircraft as well as to military missiles.

Ramjets, the youngest member of the aircraft and missile powerplant family, have made rapid strides during the past three years. The next few years promise advances even more dramatic.

Portable Lox Plant

The Army Corps of Engineers, in contract with Air Products, Inc., Allentown, Pa., has developed a highly compact, portable, 20-ton per-day lox plant for use in support of the Army's Redstone missile. The plant will operate near missile-launching sites and will be capable of following missile groups about as they are shifted to meet the needs of military operations.

Heat and Thermodynamics Letter Symbols Revised

A revised American Standard Y10.4 (1957), "Letter Symbols for Heat and Thermodynamics," replacing the one issued in 1943, is available for $1.50 a copy from the American Standards Assn., 70 E. 45 St., New York 17, N.Y., or from the American Society of Mechanical Engineers, 29 W. 39 St., New York 18, N.Y.

IGY Reports Available

Three series of reports on data obtained in U. S. IGY experiments are being issued by the National Academy of Sciences. The series fall into general, satellite and rocket categories, with seven reports already available in the first two series and the first rocket data due shortly. Priced at $1 each, reports are available through the NAS Publications Office, Washington 25, D.C.

Engineering Teachers Needed

A two-year study sponsored by the American Society for Engineering Education reveals that by 1967 American engineering colleges will need 7000 more engineering teachers.

Propellants and Combustion

(CONTINUED FROM PAGE 57)

To me, another highlight of the year was not a physical achievement but a change in the national frame of mind. I am referring here to the healthy competition between the liquid and solid partisans, and the serious attention being given to high energy propellants, free radicals and advanced types of propulsion.

Solids are advancing rapidly, and are now being developed for long-range missiles, an area formerly monopolized by the liquid propellants. The competition has, in turn, brought fresh vigor in the application of liquid propellants. This has come about because the solids have caused a shift in the ground rules of application, particularly with respect to temperature limits. Now the liquid propellant people can call in propellants previously not allowed in the ballpark.

The national attitude toward space flight has been responsible for increasing attention to the high energy propellants such as hydrogen, hydrazine or ammonia as fuels, and ozone, fluorine or oxygen as oxidizers. Spadework on high energy propellants has been done by a number of groups, among them North American–Rocketdyne, Bell Aircraft and the Lewis Research Center of NASA. What is needed is work on a specific application, and the intense interest in space flight is encouraging work in this direction.

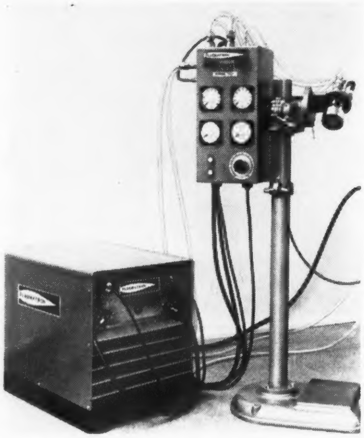
Other areas, too, are receiving attention. The stabilization of ozone and the study of free radicals for their ultimate utilization is continuing. Studies of nuclear propulsion, ion propulsion and space vehicles are in full swing.

All in all, it has been a great year for rockets and, with the momentum of activity building up, 1959 will be an even greater year.

Microwave Signals Transmitted At 21 Million Watt Peak Power

Transmission of microwave or radar-like signals many times more powerful than was hitherto believed possible has been achieved in a research project carried out by Cornell Aeronautical Laboratory for Army Ordnance. CAL has transmitted such signals at a peak power of 21 million watts. Because present-day radar equipment is considered inadequate for detection of high speed long-range missiles, the Army regards the achievement as significant to the future development of ICBM detection apparatus.

New equipment and processes



Plasmatron, a machine for generating a controlled jet of partially ionized gas with temperature greater than 22,000 F, may aid in lab research. Jet is up to $^1/_2$ in. in diam and 6 in. long; power levels designed for 12.5 to 160 kw. Giannini Plasmadyne Corp., 3839 S. Main St., Santa Ana, Calif.

Primary Battery: PM Silvercel, a high energy, reusable silver-zinc primary battery with long wet-stand life, needs only to be manually filled to be activated. Energy output, 70 watt-hr/lb. Yardley Electric Corp., 40 Leonard St., New York, N.Y.

Square-Root Integrator: A compact integrator for continuous automatic totalization of flow, the Model 26 Square-Root Integrator can be adapated to miniature strip-chart flow recorders, forming an electromechanical integrator. Linearity of the integrator, 0.25% of full scale; repeatability, 0.5% of full scale; input speed, 60 rpm; max. input shaft torque, 0.35 in./oz; shaft rotation, 18 deg /30 min; max. time shaft torque, 0.5 in./oz. Librascope, Inc., Commercial Div., 40 E. Verdugo Avenue Burbank, Calif.

Frequency Calibrator: Model 521 frequency calibrator permits calibration of oscillators and discriminators in FM-FM telemetering systems in a fraction of the normal calibration time. It provides calibrated input voltage to each voltage-controlled oscillator in the transmitting system and, by use of a center scale frequency meter, continuously measures deviations from standard frequencies. Alignment of each discriminator in the receiving system is checked by a standard frequency generated in the calibrator. Direct frequency readings are given in terms of percentage deviation. Fenske, Fedrick & Miller, Inc., 12820 Panama St., Los Angeles 66, Calif.

Mercury Diffusion Pumps: MHG-40 (water cooled) can maintain a speed plateau of at least 40 liters of air per sec in the 3×10^{-4} to 2×10^{-2} mm Hg pressure range, with peak of 52 liters/sec occurring at 10 microns. Consolidated Electrodynamics Corp., Rochester Div., 1775 Mt. Read Blvd., Rochester, N.Y.

Satellite Telescope: Especially designed for Moonwatch Program, this Unitron 6× satellite telescope may also be used as a wide-angle finder for any astronomical telescope for meteor counting, comet seeking and Rich-field observing. Features include a 52-mm coated achromatic objective, 200-mm focal length, f/4 high eyepoint, eyepiece with an 8.5-mm diam exit pupil, and focusable cross-hair. Unitron Instrument Div., United Scientific Co., 204 Milk Street, Boston 9, Mass.

Nut, Bolt and Screw Wrench: The shockproof tip wrench tightens or loosens nuts, bolts, and slotted machine screws in hard-to-reach places. By applying thumb pressure on the plunger head, the jaws open and slide out to the desired size; as pressure is released, the user is ready to complete the job. Tipco Mfg. Co., 14758 Calvert, Van Nuys, Calif.

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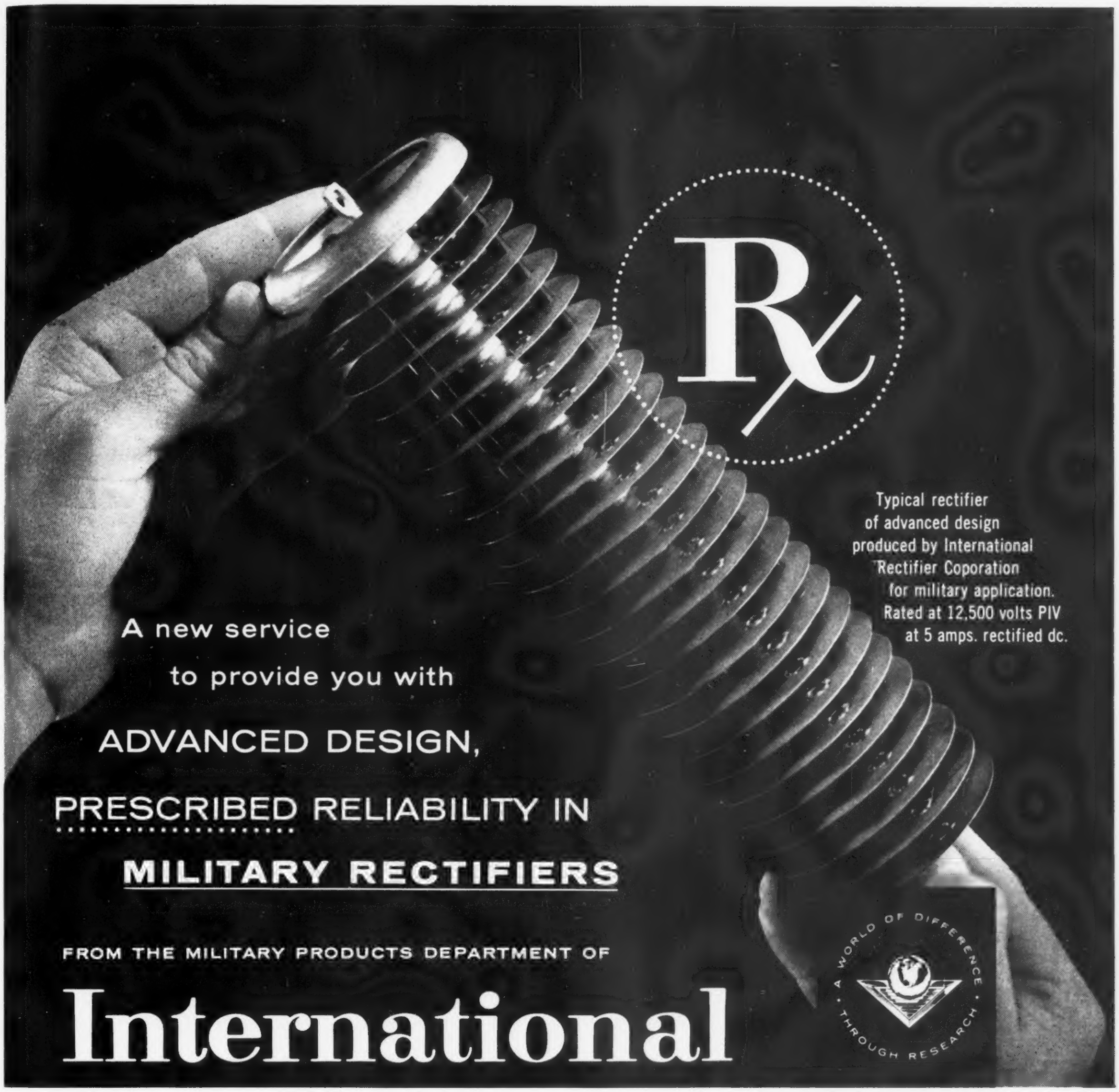

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